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Report on a Fatal Accident
and Fire at the
West London Terminal
of Esso Petroleum
Company Limited
on 1st April, 1967

LONDON

HER MAJESTY'S STATIONERY OFFICE

NINE SHILLINGS NET

HOME OFFICE

Report
on a Fatal Accident and Fire
at the West London Terminal of
Esso Petroleum Company Limited
on 1st April, 1967

by

H. K. BLACK, B.Sc., Ph.D., D.I.C., F.R.I.C.

H.M. Chief Inspector of Explosives

LONDON

HER MAJESTY'S STATIONERY OFFICE

1968

HOME OFFICE,
EXPLOSIVES BRANCH,
HORSEFERRY HOUSE,
DEAN RYLE STREET,
LONDON, S.W.1

6th September, 1967

*To: The Right Honourable the Secretary of State
for the Home Department.*

Sir,

I have the honour to report that in obedience to the Order dated 3rd April, 1967 made under Section 14 of the Petroleum (Consolidation) Act, 1928, I have held an inquiry into the causes of, and circumstances attending, the accident by fire and explosion which occurred on 1st April, 1967 at the premises of the Esso Petroleum Company Limited at Bedfont Road, Stanwell, Middlesex. An Interim Report was submitted to you on 15th May, 1967; I now submit my Final Report.

Casualties

By this accident three lives were lost and eleven other persons were injured, one of them seriously namely:

Killed

George Knott	Aged 54 years
Douglas Nokes	Aged 50 years
Ralph Webb	Aged 35 years

Seriously injured

George Betts	Aged 49 years
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Injured

Robin Chester	Aged 39 years
Dorothea Dene	Aged 16 years
George Dobinson	Aged 44 years
John Hoddinott	Aged 35 years
Peter Jay	Aged 30 years
William McWilliam	Aged 50 years
Charles Nelson	Aged 39 years
William Neville	Aged 45 years
Muriel Pay	Aged 40 years
Ronald Stone	Aged 33 years

Of the injured, Dorothea Dene and Muriel Pay suffered from shock while Ronald Stone and Peter Jay suffered injury escaping from the premises. The remainder suffered injury as a direct consequence of the fire. One of them as at this time, namely George Betts, is still under constant medical care.

Inquest

I attended an Inquest held at the Coroner's Court at Chertsey on 6th April, 1967 when evidence of identification was given. The inquest was then adjourned pending results of the inquiry ordered by the Secretary of State. At the resumed inquest, at the same court, on 31st July, 1967 I gave evidence. The Coroner, sitting with a jury, returned a verdict of Accidental Death.

Material damage

The fire and explosion caused the almost complete destruction of a line of stands used for loading road tank-wagons and, in addition, nineteen vehicles varying in size from 1,800 gallons capacity to 4,000 gallons were destroyed. The total loss has been estimated at nearly £500,000. (Plate No. 15).

Description of the premises

The premises of the Esso Petroleum Company Limited at Stanwell are known as the West London Terminal which is situated 14 miles west of London close to the southern perimeter of London (Heathrow) Airport. The eastern boundary of the flight path safety zone of the airport from No. 5 runway crosses the terminal towards the north-west; all places on the terminal where petroleum spirit is handled or exposed are outside the flight path risk zone from aircraft. The situation and the lay-out of the site are shown in Plan No. 1; an aerial view, which, in essential features, is the same as at the time of the accident, was taken in 1965 and is shown in Plate No. 1. The total site occupies about 33 acres.

The terminal is of recent construction, being commissioned as from March 1965 onwards. It functions as a distribution depot, receiving its products by pipe-line from the Esso Refinery at Fawley near Southampton, and distributing them by road and by pipe-line to destinations in and around the London area. It is licensed by the Staines Urban District Council for the storage of about 25,000,000 gallons of petroleum products of low and high flash-point. The whole of the site is within the licensed area. The construction of the site and the terms of licence correspond to the recommendations of the Home Office Model Code for such premises.

The terminal consists essentially of a storage area located at the southern end; a set of road tanker-vehicle loading stands opposite which, on the western side, is situated the administrative and control building; workshops towards the northern end; parking facilities and a wash bay for road tanker-vehicles. Access to the terminal is at the northern end through controlled gates (Plate No. 2) opening on to a short road leading to Bedfont Road. At the southern end is an access road for use in emergency by fire appliances. This road, closed by locked gates at both ends, leads into Short Lane. The whole terminal is enclosed by an "unclimbable" wire-mesh fence surmounted by strands of barbed wire.

The storage area

In the storage area products are kept in a number of steel tanks of various capacities. These tanks have a maximum height of 42 feet, which is a requirement placed upon the Company by the needs of aircraft plotting at London Airport, and of a diameter up to a present maximum of 112 feet. An additional tank of 128 feet in diameter has been constructed very recently and will come into commission in the near future; this tank is not shown in Plan No. 1 or in Plate No. 1. Planning permission has been given for one more tank of 112 feet diameter.

With one exception products of low flash-point are stored in floating-roof tanks, which are essentially safe as there is no vapour space within them, while products of high flash-point are kept in cone-roof (or fixed roof) tanks. The tanks are located within bunded areas divided by intermediate walls in conventional fashion. The bunds are of a capacity, as is usual, to contain the

contents of the largest tank within the bund plus 10 per cent of the aggregate capacity of the remainder. The bund walls, of earth construction, are surmounted by concrete walls which, amongst other things, would give some protection to fire-fighting personnel in emergency.

All tanks are fitted with water sprays on the outside for cooling purposes in the event of a fire. Foam injectors are fitted in order to put foam, in emergency, into the cone-roof tanks or on to the roof of the floating-roof tanks. Both water and foam are controlled from outside the bunds.

Additional safety features comprise fusible links which, in the event of a fire, serve to enable valves to close automatically on the outlet side of the tanks; non-return valves are fitted to the inlet side. By-passes to the tank valves enable pressure in the pipe-lines to be relieved into the tanks in the event of the pipes being involved in a fire.

The measures adopted in the storage area can be said, therefore, to make this area as safe as is reasonably practicable.

Products, which are pumped from Fawley, are received at the extreme southern end of the terminal whence by appropriate controls they are directed into the correct storage tanks.

Pipe-lines taking products out of the terminal run more or less along the western boundary of the establishment.

At no time was the storage area involved, or likely to be involved, in the fire that occurred. For a time the overground pipe-lines were compromised by a runaway blazing vehicle which stopped astride them, but otherwise the fire was confined to the road loading facilities.

Fire-fighting facilities

Within the storage area and adjacent to the terminal end of the access road are kept a foam tender, foam trailers and a high-capacity foam monitor, together with additional stocks of foam compound in cans. The remaining facilities are referred to in Appendix 1.

By mutual understanding, fire-fighting is the responsibility of the outside brigades. Terminal personnel are only concerned with first-aid measures and in rendering preliminary assistance to the Brigades when they are called in. Their functions are to open the gates of the access road, and to start up the water-pumps and the foam appliance. If necessary they would also operate the tank-drenching system in the storage area.

Road loading facilities—General

The road loading facilities are shown in Plan No. 2. They consisted of nine double-sided loading stands running due north and south. The vehicles positions were numbered 1 to 18 in the same sense. The stands dispensed about one million gallons daily of assorted products.

Products were taken by pipe-lines from the storage tanks to the base of each of the loading stands and thence via filters, control valves and meters to loading arms which were located on platforms accessible from the ground by means of iron steps (Plate No. 3).

The loading arms, of which there were up to five in number on each side of the loading stand, were arranged to swivel through about 180° and were

capable of a large up and down vertical movement to enable them to be put into and taken out of the compartments of road tankers. A self-balancing arrangement kept them in the hoisted position when not in use. In all there were sixty-two loading arms on the loading stands.

In themselves the loading arms consisted of lengths of four inch diameter metal piping, which were joined together by specially constructed knuckles (universal joints) which enabled the pipe assemblies to assume various positions so facilitating loading of vehicles which came into the loading stands. The ends of the final lengths of pipe (drop-tubes) terminated in a T-head, deflecting product in filling operations at right angles to the run of the pipes. Each T-head was provided with a neoprene rubber cushion, secured by an aluminium strap fixed to the pipe by mild steel bifurcated rivets, in order to prevent mechanical damage to the tanks into which it was placed in filling operations.

Each loading arm was designed to load at a maximum rate of 500 gallons per minute; a mercury switch on each arm actuated the pumps for product delivery when the arm was in the down (filling) position. Filling was accomplished, through open manholes, by the drivers standing on the cat-walks of the tanks of the vehicles at the same level as the loading arm platforms. Figure 1 shows the schematic arrangements of the loading arm; Plates Nos. 3, 4, 5 and 6 show the general filling arrangements and positions of vehicles at the loading stands.

Loading—automatic control

Following earlier trials in Aberdeen and elsewhere, equipment was installed towards the end of 1966 to replace an existing manual control system; this new equipment was designed to load road tankers automatically to the desired amounts. It was based, modified in the light of experience, on that operated at Aberdeen which was the proving ground for the principles of this automatic system. It was ordered from the contractors early in 1966 and was subjected to exhaustive tests at the contractors' works in August at which time other modifications were made. Installation at the Terminal began about September and was completed by December.

The new equipment involved alterations to some of the features of the existing loading stands and brought into use new methods of control and recording. It was said to increase the safety of operations on the loading stands; it speeded up operations, for it enabled loading of a number of compartments to be carried out simultaneously, so making for more efficient use of plant and men; there was more accurate control of the product and record-keeping by means of a data-logging and it allowed a certain amount of self-service by authorised dealers. It had a further advantage in that only known personnel who had their own individual key-cards could draw product from the stands. The system incorporated interlocks which operated to prevent product being drawn from the loading arms unless certain conditions were satisfied, or in the event of faults developing in the system.

The basic changes in the equipment at the stands were, first, the provision of a pre-set display head on which could be set up, by push-button mechanisms, the amounts of products required to be loaded into the various compartments of the road tanker-vehicles. This pre-set head incorporated various other features e.g. a push-button device to record and indicate the loading authority

number, control buttons and indicator lamps as well as additional switches for special mixtures. More particularly it included a spring-loaded drawer into which was required to be inserted the driver's coded personal card (the key-card) which was scanned electronically to determine whether it was authorised, the system being such that if it were not acceptable it was not possible to draw product from that side of the loading stand. The system was set up only to accept authorised cards which, in the event of any being lost, could be locked-out as required so preventing unauthorised use. The pre-set head is shown in Plate Nos. 5, 6 and 7.

Provided that the correct sequence of operations was carried out on the loading stands the driver could then obtain the products he required. Electrical interlocks prevented the system operating i.e. product being obtained, unless all relevant steps were valid. The various steps required to obtain product are shown in the operating instructions (which are a modified version of those displayed in Plate Nos. 6 and 7) in Plate No. 8.

Secondly, each loading arm assembly was fitted with an automatic valve which, instructed from the pre-set head by pressing a 'ready' button, began to deliver product until towards the end of the pre-set amount an injected signal reduced the rate of flow by about 80 per cent. A second signal caused the valve to close when the full amount had been delivered. In the event that it did not close automatically a safety device in the form of a trip-wire running along the stand overhead could be pulled by the driver so causing the valve to close and delivery of product to cease.

Associated with the loading stands was recording, controlling and over-seeing equipment, which was housed in the main administrative and control building immediately to the west of the loading stands and distant about 75 feet therefrom. The electronic equipment, switch and control gear was contained in a switch room situated on the ground floor. This was provided with two doors, both kept locked. Keys of this room were in the control of the Plant Supervisor; access was denied to all but authorised personnel. The switch room was windowless and hence the loading stands were not visible from it.

Recording and overseeing equipment was housed in the control room on the first floor, above the switch room. It was provided with windows on three sides giving a good view of the whole of the area of the terminal in which the loading stands were situated.

Data were transmitted automatically from the loading stands to a memory store in the switch room. The removal of a key-card from the pre-set head on the stands caused these data to be printed out in the control room by an automatic typewriter, which recorded all the details of the products taken. This typewriter, in ordinary working, recorded in black except when there was a fault in the system or there was a quantity error; the print-out then appeared in red. Every twenty-four hours, at midnight, or at any time on demand, the typewriter printed out, also in red, the accumulated products' total.

A display, known as the 'mimic' panel (Plate No. 9), enabled the Shift Supervisor to oversee the operations on each of the stands, by operating a rotary switch. Lamp signals indicated the situation on each loading arm at each stand and any common faults that prevented the system operating. A separate light signal indicated whether there was a typewriter fault.

Audible alarms in the control room were also associated with the lamp displays in order to draw the attention of the staff to faults in the system. They were of two kinds

- (a) an intermittent alarm which indicated an invalid key-card and
- (b) a continuous alarm which indicated a fault on the loading bays.

In combination with lamp signals the alarms also indicated a typewriter fault or a system fault.

A switch was provided to by-pass the typewriter if necessary so allowing the remainder of the system to function if otherwise it were free of faults. In these circumstances data were retained in the memory store and were recovered to print out on the typewriter automatically when it was restored, working, to the system. The memory store had the drawback, however, of limited capacity.

A talk-back system was provided to keep the control room in communication with the loading stands.

Loading—manual control

In the event of a fault developing in the automatic system which could not quickly be put right, provision was made to enable a change to be made to manual control. This meant putting the automatic valve out of action on each arm and incorporating in the loading arm a valve which could be operated manually (Fig. 1). This manual valve, which was infinitely variable so allowing full control of flow, was placed downstream of the automatic valve which in manual control had to be held wide open. Flow of product on manual control then came directly under the control of the driver through the manually operated valve. In use it had physically to be held open against a spring; when the driver released the valve-lever the valve closed of itself and hence the lever functioned as a dead-man's handle.

In manual control the driver earthed his vehicle, zeroed a meter in the flow system, opened the manhole of the compartment he wished to fill, placed the loading arm within and loaded the compartment by opening the manual valve until the meter recorded the amount required. He then released the valve lever when the valve closed and further flow of product ceased. Other compartments were then filled in the same way until his load was complete. As filling data, in these circumstances, were not automatically recorded, his load had then to be checked by the plant operators.

Change from automatic to manual control

In manual control the automatic valve had to be fixed wide open on each loading arm. This change was made in one of two ways:

- (a) by means of subsidiary valves adjacent the automatic valve; these could be adjusted to hold the valve fully open. The subsidiary valves were kept padlocked and access to the keys was denied to all but authorised personnel. The method, however, meant that each valve had separately to be attended to, and in the event of the whole system having to go over to manual the operation was laborious and time-consuming. A second method was, therefore, introduced in February, 1967,

- (b) whereby a simple electrical switch for each loading arm served to energise solenoids which kept the automatic valve in the fully-open position. These switches were brought to a central switch-board mounted in the switch room. From this central switch-board all or any of the loading arms could be changed to manual control by operating the appropriate switches (Plate No. 14).

Automatic/Manual control

There was, however, an important difficulty in that, as the manual valve had to be wide open in automatic loading, just as the automatic valve had to be wide open in manual loading, the valve lever was fitted with a cam after which the valve, when opened, could only be closed by deliberate intent, i.e. the cam did away with the dead-man's handle feature. The automatic valve then controlled the whole of the filling operation, and the system as then arranged permitted any number of tank compartments, up to the number of loading arms on the stand, to be filled simultaneously. This arrangement had the drawback, however, that if loading were on automatic control and, at the end of loading a vehicle, the manual valves were not closed and the switches were operated to change from automatic to manual control, product would then flow through any loading arm in any of the product lines that had an arm in the down position, for in this position the mercury switch on the loading arm would have actuated the pumps. Gross spillage would then have resulted.

For this reason the central switch-board was mounted in the switch room, the keys of which were held by the Plant Supervisor. The switches too were on a special board contained in a locked box, the keys to which were also held by the Plant Supervisor who, in the absence of engineering staff, would make the change to manual as and when required by the Shift Supervisor. Within the box was a flap which had to be raised in order to operate the switches. Warning notices had been painted on the outside of the box and at every conceivable place within, drawing attention to the necessity for the manual valves to be closed before the switches were operated (Plate Nos. 10-14).

Approval of the installation

The policy for the use of multi-compartment loading was formulated at Company Board level. The responsibility for drawing up the necessary specifications, getting the equipment and overseeing its installation lay with the Development and Services Section of the Engineering Department of the Company. The decision to change from individual adjustment at the loading stands to central switching was made by this Section with the approval of the Safety Officer of the Company and by the Terminal management. While the automatic system was accepted by the Local Authority who had studied its operation, the installation of a central switch-board had not been notified to them. Nor, indeed, was its existence known to the senior officer in charge of all control room staff; the Safety Officer on the plant had not been consulted in regard to its installation nor with regard to safety aspects of the equipment or of its operation, although he had observed it operating and it appeared to him to be satisfactory.

Circumstances leading up to and attending the accident

Installation of the new equipment at the Terminal was completed by December, 1966. Actual working of the equipment started on 1st January, 1967 and continued under contractors' and Company engineering control on site until towards the end of March. Just before the Easter holiday (March 23rd) the last of the Company's engineers still on site told the Terminal management that the installation was then working satisfactorily and that the staff had been instructed. Accordingly the contractors' engineers were being withdrawn and he, himself, was also about to leave. He returned after the holiday, at which time a typewriter fault had developed which the Terminal staff had been able to clear by themselves. On 30th March the engineer reported to headquarters in London that everything was running normally and, in consequence, he proposed to leave finally. It was agreed with the Terminal management that he should leave on 31st March at which time it was then the intention that another engineer at headquarters should remain on call in case any difficulty arose.

From 1st April, therefore, the new installation was under the sole control of Terminal personnel. At that time the Terminal management was prepared to accept the equipment if it ran seven days trouble free, and so notified headquarters.

On 1st April two senior officials were in charge of operations at the Terminal. First the Shift Supervisor, who was in overall charge of the site and whose special duties were in the control room dealing with control of filling operations, planning transport and carrying out checks on the system. Secondly, the Plant Supervisor who, with his staff, was responsible for all the plant on the Terminal including the loading bays and operations on these bays, which involved checking of some vehicles and loads notably those concerned with delivery of aircraft fuel.

Both of them came on duty on 1st April, 1967 before 06 00 hours and took over from their night shift colleagues with everything running normally. The Plant Supervisor found that, owing to sickness and leave, he was two men short of his staff of four but just before 07 00 hours one other man came in on overtime to help out, still leaving him, however, lacking one man on his shift.

Normal running continued until just before 07 00 hours. At that time one of the drivers on the stands (Bay 15 or 17) found that delivery of petroleum spirit into his vehicle was slower than usual, a fact that he ascribed to perhaps a dirty filter in the loading system, as had happened before, and accordingly he did not report it at the time. This occurrence, however, I believe to be the first symptom of the trouble that was to develop.

At about the same time another driver (on Bay 3) was called up on the talk-back equipment from the control room which informed him that he was loading the wrong product. The typewriter was showing that kerosene was being loaded whereas the driver confirmed that he was loading virgin naphtha. The control room reported again that the wrong product was being loaded but the driver knew that this must be an error in the record for he was in no doubt as to what he was loading. The Plant Supervisor came past the stand at that time and at the driver's request checked the load. The driver was right and the record was wrong.

In Bay No. 16 the driver was able to load his vehicle and the record (Appendix 2) showed that this was completed at 06 56 hours. Meantime in Bay No. 2 the driver was able to complete part of his load and then found that he was unable to get more product from the system. The driver who drew into Bay No. 16 after 06 56 hours was unable to get product as indeed was the driver adjacent to the driver on Bay No. 2 (Bay No. 3). Other drivers somewhat later also failed. The control room was notified.

Meantime in the control room an audible alarm sounded as a continuous note which indicated that there was a fault on a loading bay, but a lamp signal simultaneously appeared at the side of the teletype and this showed that the fault was on the typewriter. The Shift Supervisor therefore went to the switch room with an instructional pamphlet (Appendix 3) which told him how to correct a fault on the typewriter by operating certain switches in a definite order within a special cabinet. He carried out the procedure without, however, clearing the fault. In these circumstances he went to the Plant Supervisor and told him of the trouble, suggesting, on account of the difficulty, that it would be necessary to go over to manual operation. The Plant Supervisor pointed out, however, that he was short of staff that morning and as, on manual control, the loads would need checking there would be a hold-up in the flow of trucks. With that they both went to the switch room and went through the procedure to clear the typewriter fault, again without success.

At this same time the 'mimic' panel was showing what appeared to be another fault namely that an invalid key-card was being used. The Shift Supervisor went to the bay (No. 1) and went through the loading procedure anew, putting the key-card once again in the special drawer in the pre-set head, but still product was unobtainable. At that he went back to the switch room to check on the card and found that it was not locked-out i.e. it was a valid card and hence was not the cause of the failure.

While this was going on, most of the drivers, at the suggestion of the control room, had retired to the canteen where they waited until the loading system could again be made to operate. The vehicles were left at the stands, nearly every bay being occupied (Fig. 2)

The Shift Supervisor having failed to find and correct the fault, or faults, decided to have one more try to continue loading and asked the drivers to return to the stands, re-set the equipment and see whether product could then be obtained. The attempt failed and product was still unobtainable. Whereat all but a few of the drivers returned again to the canteen. At that time, therefore, all but one of the bays were occupied by vehicles and there were in all nine drivers still left on or by the stands waiting for the fault to be corrected so that loading could proceed. There was also one driver in his vehicle waiting to go into Bay No. 12 and another driver with his vehicle waiting to go into Bay No. 14. Both these bays at the time were occupied.

Then having failed to clear the typewriter fault by the procedure laid down, and being faced with what appeared to be a second incurable fault and a system that, on automatic, would not yield any product, the Shift Supervisor and the Plant Supervisor mutually agreed that they would have to go over to manual operation. The Plant Supervisor thereupon asked the Shift Supervisor to tell the drivers to go and close the manual (EMCO) valves on the loading arms, and told one of his men to go to the loading bays and check that they were closed.

He then went to his office to fetch the key of the special cabinet which housed the switch-board and returned to the switch room. On his way back he met a group of drivers and inquired whether the valves were closed. They confirmed to him that they were. He, however, did not check with the other two men he had sent out.

In the switch room he opened the cabinet and operated the switches. Shortly afterwards he heard an explosion and, going outside, saw a fire on the loading stands with flames across the yard towards the office building. He went immediately to one of the emergency stop-buttons and, pressing it, stopped the pumps supplying product to the stands.

Meanwhile the plant operator had gone to the loading stands as instructed to check that the valves were closed. Starting at Bay No. 18 he said that he closed one or two of the valves himself while calling to other drivers to do the same to theirs. He went the whole length of the stands and was on his way back to the office when he heard a crash behind him which he said was due to a loading arm hitting the ground. Looking back from a distance of 10 to 15 feet from the stands he saw loading arms falling to the ground while discharging product. He then saw a flash somewhere between Bay 11 to 14 and an immediate fire.

At this time also, about 07 30 hours, the Shift Supervisor was in the canteen, having just asked the drivers to go to the stands and check that their manual valves were closed. While he was doing this a number of them called out that petrol was overflowing on the stands. When they all turned to look they found that petrol was overflowing from tank compartments and was discharging from a number of loading arms, which were in process of falling to the ground. Shortly afterwards there was an explosion and a fire which seemed to start in or about Bay No. 13 and very quickly almost the whole of the stands were involved together with the vehicles standing there.

One of the vehicles, that standing in Bay No. 2, ran away, probably started up by the fire as it was a diesel tanker and it had been left in gear, crossed the yard and finished astride the overground pipe-lines where it remained blazing.

Understandably there was a degree of panic amongst the personnel at the sight of what must have been an enormous fire. Many of them sought escape from the premises via the tank farm or over the fence. Fortunately there were a number with sufficient control to deal with those badly injured in the fire, to summon the fire brigades and ambulances and get the injured off to hospital, to close the product valves on the lines from the tank farm and to prepare fire-fighting facilities in accordance with standing orders. The situation was dealt with as well as could be expected in the circumstances.

The explosion was heard at the Fire Station on London Airport and fire was reported to the Station Officer from the airport watch tower. On his own initiative this officer, Mr. F. W. Williams, and twelve men set out across the airport with a foam tender, a water tender and another appliance while asking his headquarters to request the London Fire Brigade to provide stand-by cover during his absence. He arrived, with his men, within a few minutes of the fire starting. He was able to sweep the loading bays with a super jet from the foam tender and keep the fire under control pending the arrival of reinforcements from the public brigades. He also dealt with the other potentially very dangerous situation in which the blazing tanker was astride the pipe-lines taking products out of the Terminal.

The initiative and resource of this officer were of a very high order and reflect the greatest traditions of the Fire Service. His action prevented a more serious accident, serious though the existing situation was. He is worthy of the highest commendation.

Very shortly the outside brigades arrived, first from Staines at 07 42 hours to be followed by others from the London and Surrey Fire Brigades. The Divisional Officer from Surrey arrived at 07 53 hours and assumed overall command.

The fire was tackled with great skill and resolution and was finally extinguished by about 08 40 hours, that is about one hour after the fire started. That it was so extinguished is a great tribute to the conduct and training of the Fire Service no less than to the leadership displayed. In these days when the Fire Service is taken so much for granted, it gives me more than usual pleasure to record the expressions of undisguised admiration of the Fire Service made to me by Esso personnel during the course of the inquiry.

Result of the fire

The casualties and material damage to the Terminal have been referred to. The fire put the Terminal out of commission with regard to road deliveries until temporary facilities were erected, with the approval of the local authority, and taken into use on 8th June, 1967. Re-building of permanent facilities is under consideration at the present time.

Cause of the spillage

The first thing observed at the stands was gross spillage of petroleum products from the loading arms, some of which were discharging into compartments of the road tankers while others were discharging freely on to the ground at what must have been the maximum rate of 500 gallons per minute for each loading arm involved.

Examination of the central switch-board which enabled any or all of the loading arms to be switched from automatic to manual control and vice versa, disclosed that all save one were in the down or "manual" position thus showing that the change to manual control had been effected. The cabinet housing this switch-board was found to be locked and inquiry established that this was the position of the switches at the time of the accident.

In operating the automatic system it was clear from many drivers' statements that, notwithstanding instructions from the management, reliance was placed on the automatic valves and, not infrequently, the manual valves were left in the locked-open position after loading of vehicles was completed. The spillage can only be accounted for on the assumption that this state of affairs existed at the time the switch-over to manual control was made.

Examination of the stands on the day following the fire, and subsequently, showed that a number of valves on the loading arms were in the locked-open position but, in the absence of knowing to what extent they had been interfered with following the fire, it is not known how many were open at the time of the fire; it was presumed from the evidence that some, at any rate, were in fact open.

As explained in the description of the premises, if these valves were open and the system were switched to manual operation, then product would discharge from every loading arm, whether in the hoisted position or not, that was

on a product line which had one of the loading arms in the down or filling position, for the mercury switch on that loading arm would have started the product pump.

Undoubtedly some of the valves were open and undoubtedly the switch-over to manual control had been made. The spillage is thus fully accounted for. How many of the loading arms and how many products were involved is not known.

The origin of the fire

The reason for the large spillage of petroleum products are clear enough, namely that the system was switched from automatic to manual loading when some of the loading arms were in the down position, and hence had actuated the pumps, while at the same time the manually operated valves on a number of loading arms had been left open, so allowing discharge of product.

Close questioning of witnesses produced the unanimous opinion that the fire originated in one of the bays; it did not start from outside. The belief was that it started somewhere in Bays Nos. 12-14 with a considerable balance of opinion in favour of Bay No. 13

The reason for the products going on fire is less clear but nevertheless a selection can be made from possible causes as to indicate the most likely cause, or set of circumstances, that would bring it about. The possible causes may be listed as follows:

- (a) Smoking, or the use of matches, at or in the vicinity of the loading stands;
- (b) An open flame or other such source at some distance from the stands;
- (c) An electrical fault in the equipment of the stands;
- (d) An atmospheric discharge;
- (e) Electrostatic discharge;
- (f) A spark generated from a falling loading arm
 - (i) as it struck the ground
 - (ii) as it struck a tanker or part of a stand on its way to the ground;
- (g) From a road tank-wagon near to the stands.

Of these possible causes there was no evidence to suggest that there was smoking or matches being used at or near the stand, nor was there any evidence of an open flame or similar source more remote from the stands as could lead to an ignition. They have, therefore, been rejected as possible causes. Equally, on the morning of the accident there were no atmospheric electrical disturbances reported from the Meteorological office in the area of the West London Terminal (Appendix 4) and, in consequence, weather conditions have also been eliminated. That leaves four possibilities which will be examined in turn.

An electrical fault in the equipment of the stand

Each loading stand was fitted with electrical equipment fed by current-carrying cables running in a trench beneath the stands from end to end of the installation. This trench was connected by two trenches to the switch room in the main building opposite the stands and contained power and control cables linking the switch room to the stands.

The whole of the installation was checked through in detail by the Electrical Adviser to the Home Office and a report rendered to me which is reproduced at Appendix 5. His conclusions, which I accept, are set out on pages 35 to 37 of this report. I have, therefore, rejected a fault in the electrical equipment of as being a cause of the fire.

A spark generated from a falling loading arm

(a) as it struck the ground

Witnesses gave evidence of the fall of a number of loading arms some of which, notably one on Bay 13, were said to have fallen to hit the ground with some force, and the possibility, therefore, arises of the generation of a frictional spark as they hit the ground.

Each terminal pipe of the loading arms was made of aluminium alloy. The bottom of the open end was provided with a moulded isoprene-rubber cushion pad held in position by an aluminium band secured to the pipe by bifurcated rivets. The specification called for rivets made of aluminium, but examination of the loading arms disclosed that some of the rivets had rusted and it was established that they were, in fact, made of cadmium-plated mild-steel. It is possible, therefore, that a spark could have been generated from one of these rivets or, as a very remote possibility, minute particles of aluminium alloy could have been struck off and they subsequently, as they may have been pyrophoric in nature, became incandescent by oxidation in the air.

While the generation of a spark from the rivets remains a possibility, it must be borne in mind that the reason for the fall of the loading arms was due to product being pumped through them and issuing from the open ends. Bearing in mind that there is only a very narrow range of concentration of petroleum-spirit vapour in air (2%-9%) in which the mixture is inflammable, had there been a spark at the open end of the pipe it is considered that the possibility of it setting fire to the petroleum-spirit was not very high, due to the fact that the concentration of petroleum-spirit in the air would probably have been well above the inflammable range.

(b) as it struck a tanker or part of the stand

Aluminium, even in the form of some of its alloys, is capable of generating incendive sparks, as has been known for many years, by frictional contact with rusty iron; a mixture of aluminium powder and iron oxide forms the well-known thermite mixture. Experimentally, a streak of aluminium on a rusty iron surface, and variations of this technique, will readily yield, by a glancing blow, sparks of high energy which can ignite mixtures of inflammable gas with air.

Examination of the stands showed many places with a sufficient rust deposit which could lead, in favourable circumstances, to the incendive spark reaction. It, therefore, became necessary to find out whether the actual aluminium alloy used for the pipes could produce such sparks.

Samples of actual pipes were submitted to the Superintendent of the Home Office Branch of the Royal Armament Research and Development Establishment at Woolwich who carried out experimental work on which he reported. His report is reproduced at Appendix 6.

The experiments showed that:

- (i) When the pipes were struck against rusty iron and steel surfaces, large sparks or flashes were produced;
- (ii) Aluminium on a rusty surface could produce, when struck, sparks which ignited a methane/air mixture;
- (iii) Smears from the pipes on a rusty surface produced large flashes or sparks.

It must be concluded, therefore, that the possibility existed in the conditions of the accident for a spark or flash to be generated which, in the right conditions, could have ignited petroleum-spirit. Moreover, it would be more likely for the side of the pipe, rather than the end, to come into frictional contact with a rusty surface, and a spark, or flash, being generated in such a position would involve the risk of ignition, as it would occur at a little distance from the open end of the pipe from which product was issuing, and hence at a place where concentration of inflammable vapour was more favourable to ignition.

From a road tank-wagon near to the stands

It is known that a few vehicles were parked so as to be able to enter loading bays when those already in position had filled up and left.

In two of them, a few feet behind Bays Nos. 12 and 14, were two drivers waiting to drive into these bays when those already in position had filled up and left.

The driver of the one said that he was sitting in his vehicle, with the engine switched off, when he noticed one of the loading arms in front of him discharging product. He got out of his vehicle, intending to close the manual valve on this arm, when there was an immediate explosion and flames, at which he turned and ran towards the canteen.

In the other vehicle the driver was sitting in his cab with the engine switched off when he noticed the rear loading arm of the bay in front of him discharging product, and dropping down behind the vehicle in the bay. Fire then seemed to come from the ground near to the loading arm to which he referred. He immediately started his vehicle, reversed it and drove towards the tank farm.

Notwithstanding the statements of these drivers that their engines were switched off, a doubt must remain. Witnesses told me that engines of vehicles just outside the loading bays were sometimes left running to warm them up on cold mornings. The morning of 1st April was cold and, accordingly, it is possible that one, or both, were left running that morning.

Equally a doubt must remain as to whether one of the engines was started before or after the fire occurred.

If one, or both, of these engines were running at the time, or the one was started up after the spillage occurred but before the fire, either situation could have been the origin of the fire.

Electrostatic discharge

The last of the possible causes of the fire at the loading stands, is that of electrostatic discharge.

It is known that when surfaces are separated charges of opposite sign are induced on the separated surfaces. When liquids such as petroleum-spirit,

which is an electrical insulator, pass through a pipe-line, charges are induced in the liquid for the same reason. Above a critical speed sufficient electrical charge may be developed to provide a real hazard if spark discharge to earth occurs. For this reason the liquid speeds in the loading arms were kept below the 20 ft/sec said to be accepted as the critical speed in these circumstances, and the loading arms and tankers were connected to a common earth. Any charge then developed during loading operations would be conducted to earth before it reached a magnitude to become hazardous.

However, at the time of the accident there was free discharge from the open pipes, and it is known that significant electrical charge can be built up in these conditions, particularly when the liquid breaks up into drops or it splashes as it must do in these circumstances. If then there is a collector and a path to earth, flashover can occur of an intensity sufficient to ignite highly inflammable vapour/air mixtures. These conditions were present at the time of the accident. There was free discharge from open pipes with considerable splashing, one of a number of objects could have acted as a collector and there was a path to earth through the tankers or through the loading stands.

The most likely cause of the ignition

Of the causes that must be accounted real possibilities the most likely are considered to be:

- (a) an ignition resulting from the fact that engines of vehicles behind Bays Nos. 12 and 14 may have been running, or that one was started soon after the spillage and
- (b) an ignition resulting from an electrostatic discharge.

Of these, the coincidence that all the evidence shows that the fire originated in, or about, Bay No. 13 is too strong to be ignored and I, therefore, consider that the fire originated most probably with these vehicles. Of the two possibilities in regard to the vehicles themselves I consider that of starting the engine of one of them to be the most likely.

Nevertheless it must also be said that electrostatic discharge cannot be dismissed as a possibility, nor that of an incendive spark being generated from the aluminium alloy of the loading arm in the manner described.

Conclusions

I conclude, therefore, that the accident was the result of:

- (a) changing the whole of the loading stands from automatic to manual control in a situation where, in a number of loading arms, the manual control valve was in the locked-open position and one or more of the loading arms were in the down position, and hence had started the pumps, so causing product to be freely discharged from every loading arm that had an open valve in a product line in which the pumps had been actuated, followed by
- (b) starting up the engine of a vehicle immediately behind the loading stands at the time of the spillage, as the most likely cause of the fire.

General discussion

(a) *The accident*

The decision to override the individual controls on the loading arms by means of a central switch-board, without the most rigid safeguards, was a

tragic one. After its installation an accident from that moment on became inevitable sooner or later. It may be that on the occasion of this accident the Plant Supervisor was at fault in not checking with the two men he had himself sent out that all the valves were closed, before he operated the switches, although a group of drivers did tell him that they were, which could have meant, and probably did, the valves on the stands that those particular drivers were loading from. But a display of warnings on the switch-board was only a poor safeguard in such a situation, particularly in the absence of an organised plan for checking the stands and subsequently posting guards to ensure that the valves were not interfered with during the change-over. In my view the circumstances of the accident should have been foreseen, and interlock devices built in to make such an accident impossible. The fact that warning notices were exhibited showed that the danger of a major spillage was appreciated, but I doubt that there was a full realisation that, in the case of such a spillage, there was the possibility that the petroleum-spirit could go on fire of itself, by reason of an electrostatic flashover i.e. without the presence of a naked flame source, or that with such a large spillage there could be a strike-back from quite a distant source.

That this switch-board was installed, with the approval of the Terminal management and with the knowledge of the Company's Safety Officer, in a switch room from which the loading stands were not visible, suggests some failure to take into account the basic fundamentals of safety in operation of plant.

It would have been expected that the installation of sophisticated equipment would have demanded concurrently an organised system of training for all personnel, not only for the purpose of ensuring that they were familiar in detail with its operation, but that they were also trained to recognise faults that might develop and how they might be corrected, in so far as might reasonably be said to be within their competence and responsibility. Such training should have included instruction as to the circumstances in which the services of trained engineering staff should have been called upon.

The drivers were instructed in the general plan underlying the new system, and were trained in the operations required for loading road tank-wagons. A record was kept of those that had been trained.

Even though the contracting company's engineers and those of the Esso Company were on site over a long period of time, no such scheme of training was organised for the operating and supervisory staff, nor was any record kept of those who were regarded as proficient either in operating the plant or in the recognition of faults and their correction. The Company's engineers were available to train staff at the Terminal and, indeed, tried to do so, but it was only partially successful. On occasion even when training sessions were arranged no one turned up, as personnel were unable to be spared from the daily operational tasks of the Terminal.

For the most part the Shift and Plant Supervisors had acquired what knowledge they had of the equipment from one explanatory lecture, from one or two instructions sheets e.g. see that reproduced in Appendix 3 and what they had managed to pick up from the engineers in such conversations with them that they had had. None could be regarded as fully competent in the operational use of the equipment.

The standard of instructions issued can be judged from the sketch Appendix 3 and from Appendix 7 which had been pinned up in the Plant Supervisor's

room. No operational or instructional manual had been issued by 1st April although at that time one had been prepared in manuscript and was awaiting typing.

Of the two members of the staff immediately involved at the time of the accident, the Shift Supervisor had had no formal training. He had found out for himself how the equipment operated by talking to the engineers when they were putting it in. He had tried to correct a typewriter fault for the first time on 1st April. He did not know the location of the central switch-board nor did he know the switching procedure.

The Plant Supervisor had only fragmentary instruction on the new system. He had never changed any single loading arm or a complete bay from automatic to manual loading on the stands, and had no instructions as to how to effect the change by means of the central switch-board. What he knew of this he had picked up from the Contractor's engineers while they were on site.

(b) Reporting of accidents

The Company, giving notice of the accident in their letter of 3rd April to the Secretary of State as required by Section 13(1) of the Petroleum (Consolidation) Act, 1928 said that the occurrence was reported to the Duty Officer, Home Office, Whitehall at 12 35 hours i.e. about five hours after the outbreak of fire, after previous efforts had been made without success. A garbled report giving the wrong location was passed on to one of H.M. Inspectors of Explosives who understandably, from the nature of the message considered that no immediate action was called for. The Chief Inspector heard of the accident quite by chance from the B.B.C. Television news broadcast at 13 00 hours and went immediately to the Terminal.

The reason for the delay in reporting the accident was not clear, nor why the message received by the inspector spoke of a fire at Stanmore instead of Stanwell. It may have been connected with the seriousness of the situation at the Terminal and the fact that personnel in the conditions there prevailing at the time would, perhaps, not be expected to behave normally and pass clear messages to the outside. Nevertheless, bearing in mind that the fire was out at 08 40 hours, or thereabouts, something better should have been accomplished to ensure that the facts as then known were accurately reported to the Department or, better, that the terminal staff should have spoken directly to an inspector.

When the Chief Inspector arrived, sometime before 14 00 hours a good deal of clearing up had already taken place and vehicles removed from the stands. It was impossible, therefore, at that time to form an idea of what the situation had been when the fire occurred, nor was it possible to trace, at the site of the fire, what might have been vital evidence, if such existed, as to the cause of the fire.

It is of the utmost importance that immediate notice is given to the Department so that a decision can be taken as to what action it wishes to take by way of investigation and inquiry. The instructions of the inspector should be followed and, in general, they will be to the effect that if he intends to visit the scene of an accident, nothing should be done by way of clearing up, except what may be necessary to maintain a safe situation, until he arrives. It is essential that things remain untouched. In this way there will be a better chance of discovering the causes of an accident and devising ways of preventing such an accident occurring again.

(c) *Safety*

During the course of my inquiry into the accident a number of matters bearing on safety came under close scrutiny. It will be convenient to deal with them in turn.

The general safety standards were lower than it was reasonable to expect at a Terminal of this kind. Improvements can and should be made by the proper conduct of workers, by alterations in procedure and in equipment. A training and education programme for the workers is called for.

(i) *History of the Terminal*

Two serious accidents have occurred at this Terminal in about 18 months, the first in August, 1965 which caused major damage to plant but fortunately no injuries to personnel, and the second in April, 1967 which is the subject of this report. Neither accident should have been allowed to happen. Indeed I have to say with regard to the second accident that had the same imagination and the same zeal been displayed in matters of safety as was applied to sophistication of equipment and efficient utilisation of plant and men, the accident need not have occurred.

(ii) *Matches, lighters and forbidden articles*

The stands and debris were examined immediately after the fire without discovering anything which could suggest a cause of the accident. From the debris, however, was recovered an empty book-match cover and the remains of a non-flameproof flashlamp.

In a search of the site, cigarette ends and empty cigarette packets were found outside the canteen, spent matches were found in the telephone kiosk outside the administrative block, while further cigarette and tobacco packets and wrappers were found on the grass verge to the immediate west of the parking lot, and on the parking lot itself. It was said that they probably came from the waste bins behind the canteen. I was not satisfied with this explanation. No explanation was offered for the presence of spent matches in the telephone kiosk.

Matches and lighters were freely carried on the person at all times, even when filling and driving vehicles. This was not in accordance with the Conditions of Licence; carriage on the vehicle is an offence under the Conveyance Regulations.

Carriage on the person was no doubt due to the fact that the means of lighting cigarettes and pipes in the canteen often did not work, owing to pilfering of the electric element, and also to the need of drivers to smoke while away from the Terminal. Proper means should be provided and maintained in the canteen.

(iii) *The site*

The site was not of outstandingly good design in respect of the loading stands which were all together in one line. It would have been safer to have sub-divided the risk, say in three stands of six bays each. This would also have provided the opportunity to separate high and low-flash products on to different stands which, amongst other things, would prevent mistakes in loading.

In addition there is much to be said from the point of view of fire-fighting, for an echelon arrangement of groups of stands oriented to take account of prevailing weather conditions. Appendix 8 suggests that an orientation south-west would be of advantage.

Escape from the terminal was by way of the controlled gates or over the fence. The feeling of being shut in and somewhat helpless was stated by a number of witnesses, who remarked on the difficulty of getting over or under the fence. Consideration should be given to alternative means of getting out of the Terminal in an emergency.

(iv) *Fire protection*

This is dealt with in detail in the report at Appendix 1. The conclusions of the survey were that there is need for a general tightening up of the fire defence arrangements and that the top management should show its concern for improvement.

Elsewhere abroad, water-mist or foam dispersing units are sometimes installed at loading bays to keep a fire under control. These may be by manual or automatic operation and serve as a useful means of safeguarding drivers who, in the event of a fire, may escape with less serious injury than otherwise would be the case. Investigation should be made to see whether such a system could be developed in the United Kingdom and its probable value assessed.

More asbestos blankets, strategically placed, should be provided for emergency use, as well as spare clothing, and an appropriate safe place in which to change clothing which has become contaminated with petroleum-spirit.

Proofing of the drivers' overalls against fire might be considered and making them more easily removable in emergency. The design of overalls might also be improved by the removal of breast-pockets from which things can so easily fall.

(v) *Loading stands and operations*

Notwithstanding the previous accident, electrical cable ducts still ran the length of the stands, and these cables and junction boxes were found to be under water which also contained quantities of oil. Entry of cables to the stands was through unsealed earthenware pipes which had broken away to stand-base level so allowing entry of petroleum-spirit vapour, or liquid in the event of a major spillage, to the cable ducts. The arrangement should now be changed.

Consideration should be given to re-designing the loading stands. Escape from the rear (eastern end) was difficult on account of the vertical steel ladder provided. This should be replaced by suitable steps as at the front end. The design should be such as to provide the safest means of escape. Overhead pipe-lines, valve and filter gear would be the ideal arrangement.

No reason is seen why loading arms must come down to ground level. A suitable stop would keep them off the ground if inadvertently they fell.

As spillages occur from time to time and as they are, and should be considered to be, occurrences of potentially great hazard, some re-design of the base of the stands should be undertaken in order to confine the spillage within the bay in which it occurs.

Materials of construction should be examined, more particularly with a view to replacing the potentially hazardous aluminium.

Each loading arm is designed to load at 500 gallons per minute. In so doing the same volume of vapour/air mixture is discharged to the atmosphere. In the event of a number loading simultaneously, as is not unusually the case, a very large quantity of this mixture is released so creating a potentially hazardous situation. The question should be examined as to whether the speed

of loading has now not gone too far and whether rates of loading ought not to be reduced to more reasonable figures say to a maximum of 250 gallons per minute. This might be combined with a closed circuit loading technique, or collection of vapour with discharge at a remote point. Such a scheme would be easier of accomplishment were bottom loading of vehicles introduced.

Notwithstanding the importance of closing the manual valves on the loading arms, the operating instructions on the stands (Plate No. 8) contained no such reference. The omission should be rectified in the event of the procedure requiring it in the future, and in all other cases care should be taken to ensure that procedural instructions are clear, concise and complete. They should include the requirements that on leaving the stands, other than in emergency, personnel must ensure that all valves are closed and the arms hoisted, and manhole covers closed.

In the automatic system it was an essential safeguard that product could only be obtained after a proper earth connection had been made. This safeguard should be incorporated into every other form of control and arrangements should be made for the direct electrical bonding of loading arm and tanker. Consideration should also be given to the possibility of adding antistatic substances to all grades of petroleum-spirit.

In order to eliminate some of the hazard in regard to movement of vehicles when loading is taking place a barrier, which could be in the form of a painted line on the ground, should be established at a sufficient distance from the loading bays at which vehicles, with engines stopped, should be required to wait until space were available in the bays to drive in. Some consideration should be given to the possibility of ceasing filling on the adjacent bay while the movement of another vehicle takes place.

Spillages of petroleum-spirit at the stands should be regarded as serious occurrences. In the event of a major spillage all personnel should be withdrawn from the stands until the spillage had been cleared up and it were certified by a competent person as being safe to proceed. In less serious cases it might be sufficient to close down bays between neighbouring stands.

The prohibition on tipping excess petrol into the gulleys by the stands should be rigidly enforced.

There was evidence that when the spillage occurred on 1st April, personnel tried to close the valves and, in so doing, became drenched with petrol. Personnel should be instructed, as part of their training course, that in such circumstances where contamination of clothing may result, no attempt should be made to rectify matters on the stands which they should leave immediately and retire to the special changing area until it is known that they are free of petroleum-spirit.

In the event of a major fault developing in the system, all personnel should be withdrawn from the stands until the fault has been rectified and it has been certified by a competent person as being safe to resume loading.

As it appears likely that the vehicle in Bay 2 ran away because it was started by the fire while left in gear, it would seem desirable to require that vehicles should not be left in gear at the loading stands.

(vi) *Petroleum spirit-vehicles*

After the fire every vehicle was examined and a report rendered to me. The summary of the report is reproduced at Appendix 9 from which it will be

seen that a number of vehicles using the Terminal did not comply with the current conveyance regulations. The Company should ensure that no vehicle is permitted to load petroleum-spirit, or to draw into a stand from which petroleum-spirit is dispensed, unless they are satisfied that it is fully in accord with the requirements of the regulations.

(vii) *General supervision*

There appears to be a need for more detailed supervision by senior staff of operations on the Terminal and closer and regular examination of the facilities provided.

(d) *The automatic system*

I saw nothing wrong in principle with the automatic system. I was not satisfied, however, that the equipment installed at the West London Terminal had reached the stage of development that would warrant it being used for routine operations, certainly not on the scale of that required at the Terminal which should not be used as a site for perfecting such equipment. I was not satisfied either that the full implications of using such a system, in the operational background of the Terminal, had been realised; it was clear that the staff had not been properly trained to operate it. Moreover, having put the equipment in, consideration should have been given to bringing it up to operational standard using high flash-point products.

The equipment should be looked at again and modifications made before such equipment is taken into use. Study should be made of the safety devices in order to be satisfied that they cannot be defeated by any combination of circumstances likely to arise in operations.

(i) *The pre-set head*

I found the push-buttons somewhat small and inconvenient to use. They could, with advantage, be made larger with larger and bolder figures to indicate the amounts pre-set.

I was told of spillages of two kinds:

1. due to wrong amounts being pre-set. One that came to my attention concerned a setting of 8,000 gallons instead of 800. This situation could be avoided by taking into account the maximum size of compartment at present permitted under the regulations (1,100 gallons) and ensuring, by appropriate interlocks, that the system, on petroleum-spirit, would not accept more than 1,100 gallons.

A further development of this would be to incorporate an additional head on which would be set the capacities of the tank compartments which would override the amounts pre-set so that delivery would be monitored and the system, in any event, would automatically shut down when the volume of the tank compartment had been delivered.

2. due to the automatic cut-off failing to operate when the amount pre-set had been delivered. This could also be avoided by the suggestion under 1 above.

(ii) *Safety interlocks with central switching to manual operation*

I have earlier referred to the incorporation of a dead man's handle into the manual system. Beyond this an interlock should be provided preventing a change to manual control until the manual valves were closed. Moreover, if

the switches were brought again to a central position allowing the whole of the stands to be changed at one point, the central switch-board should be placed in such a position that the loading stands were fully visible. Each occasion for such a change, together with the circumstances requiring it, should be logged

As some difficulty in understanding the switch-board was experienced on a former occasion when some of the loading arms were to be changed, a clearer presentation seems to be desirable.

(iii) *Central switching*

In the event of all the bays being switched to manual, personnel should be withdrawn from the loading stands and guards posted to ensure freedom from interference until the change has safely been made. Consideration should be given to such withdrawal in the event of switching being required not involving the whole of the stands.

(iv) *Training of personnel*

There is an obvious need for training personnel before such sophisticated equipment is installed again at the Terminal, or elsewhere. Such training should include recognition and rectification of such faults as lie within the competence and responsibility of shift personnel, as well as in the routine operation of the equipment. Records should be kept of such training with dates when personnel were adjudged proficient. Periodic refresher courses should be arranged.

A manual of operation and recognisable faults should be prepared and issued to all personnel "passing-out" before being allowed to take charge of the plant.

(e) *General training*

Some very curious beliefs were expressed to me during the course of the inquiry, notably by the drivers. It would seem, therefore, to be of advantage to give all personnel some instruction in the properties of highly inflammable liquids, in the hazards to which they give rise and how they can be minimised. This would lead to a better understanding of the rules which are laid down to ensure safety in handling these liquids, and would probably promote a better acceptance and observance of the rules to the increased safety of all concerned.

(f) *Managerial instructions*

Many of these, of necessity, have to be issued to staff. As the control staff are very busy people it would help in their control of the plant, and have an influence on safety, if all instructions were codified and put in ready reference files so doing away with the bundles of unsorted documents that were handed to me for study.

(g) *Drivers*

Study of the autopsy reports suggested that the medical fitness of all personnel to drive heavy vehicles, which may carry up to 6,600 gallons (25 tons) of petroleum-spirit, should be checked and the drivers subjected to regular medical examination, say at not more than yearly intervals. Those not fully medically fit should be rigorously excluded from driving petroleum-spirit vehicles. The alleged ages of the drivers should be checked.



Plate No. 1

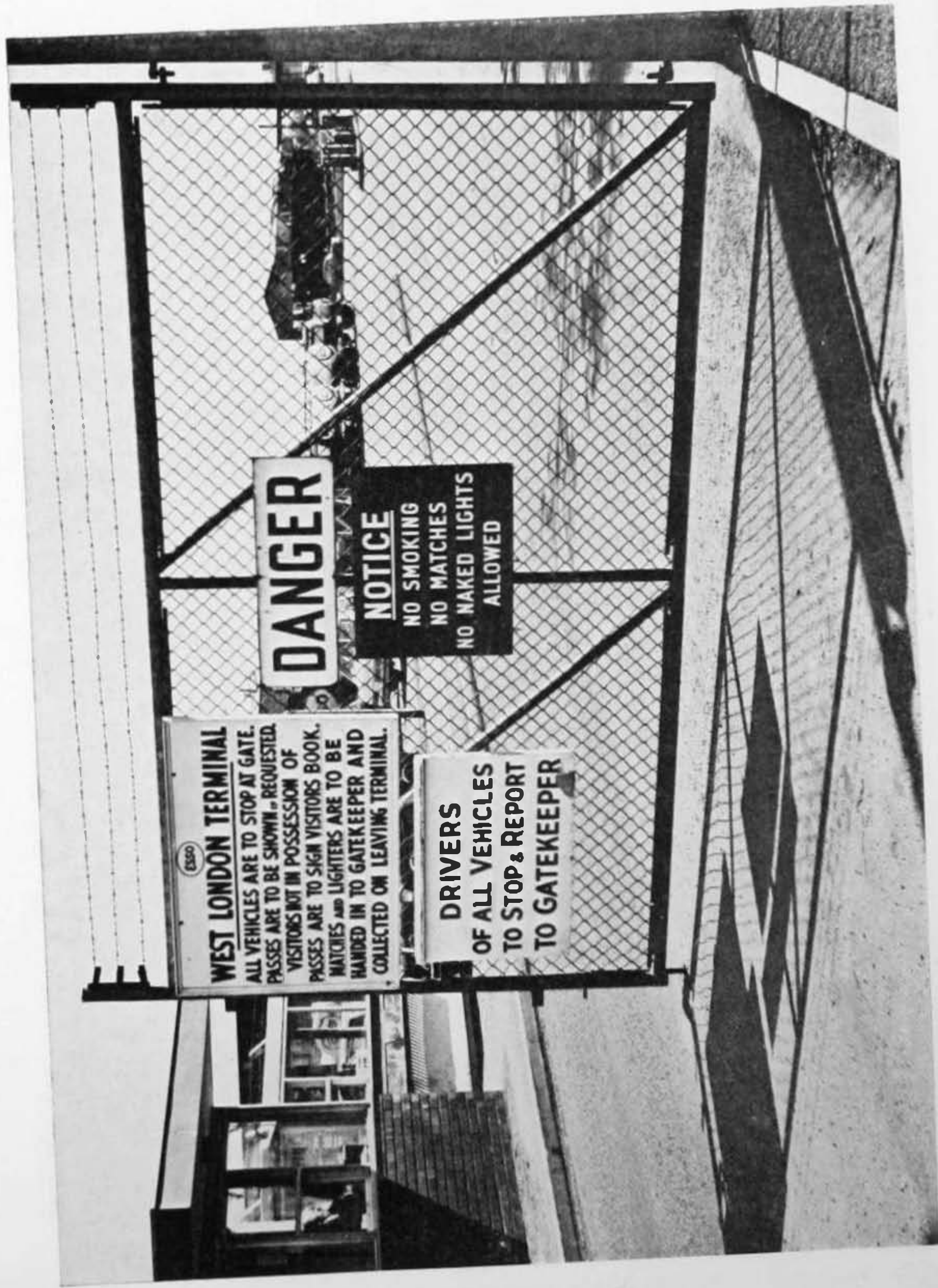


Plate No. 2



Plate No. 3

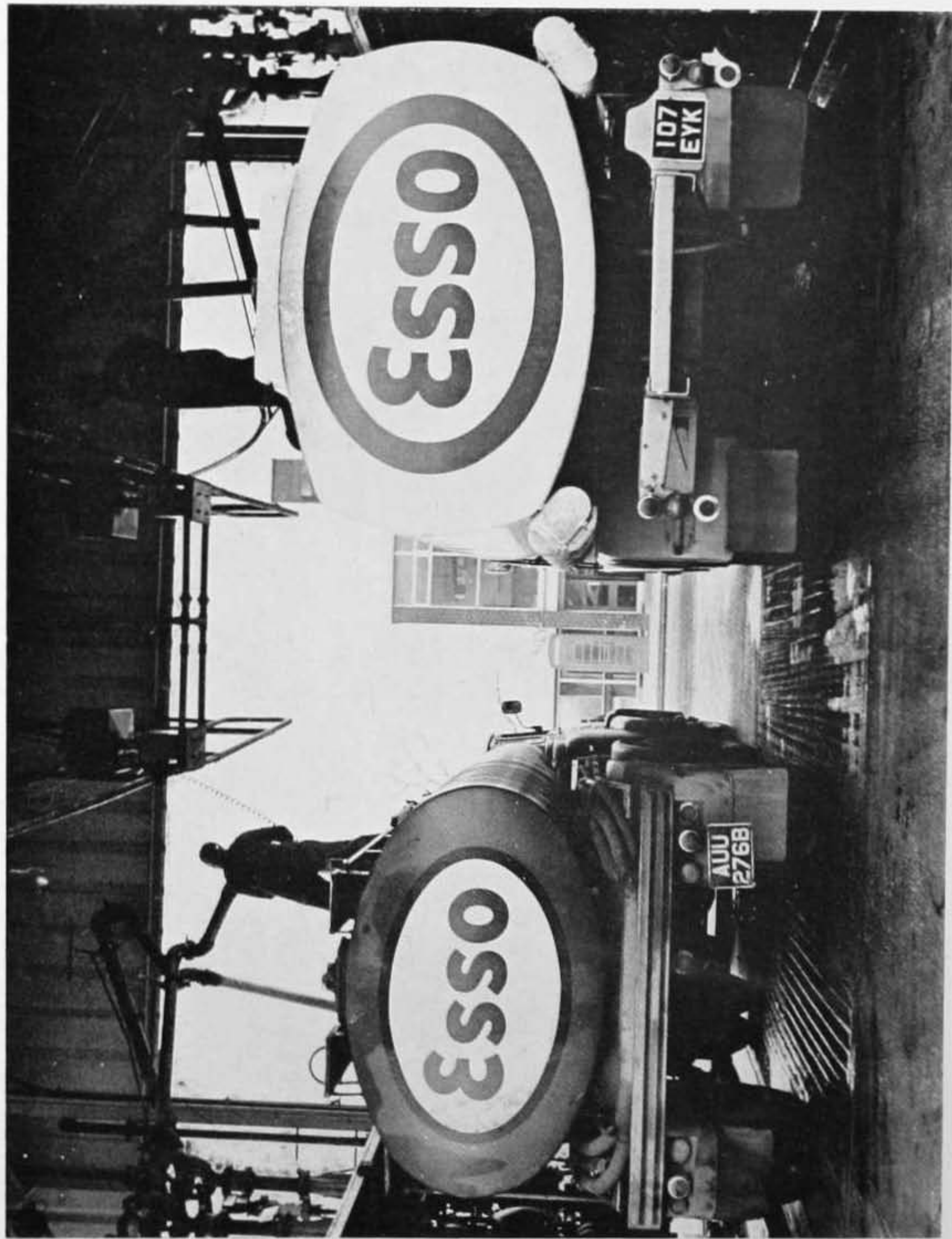


Plate No. 4

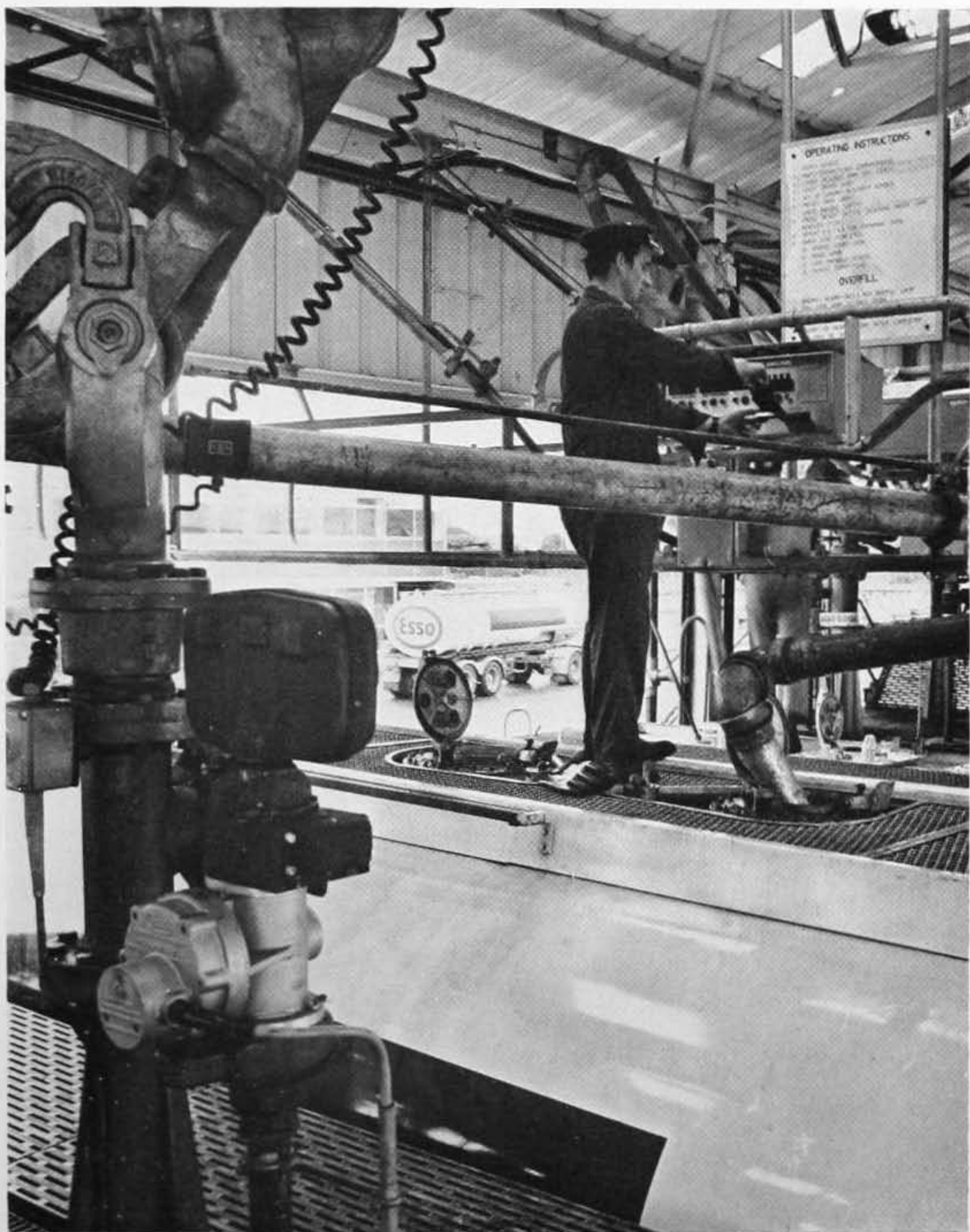


Plate No. 5



Plate No. 6

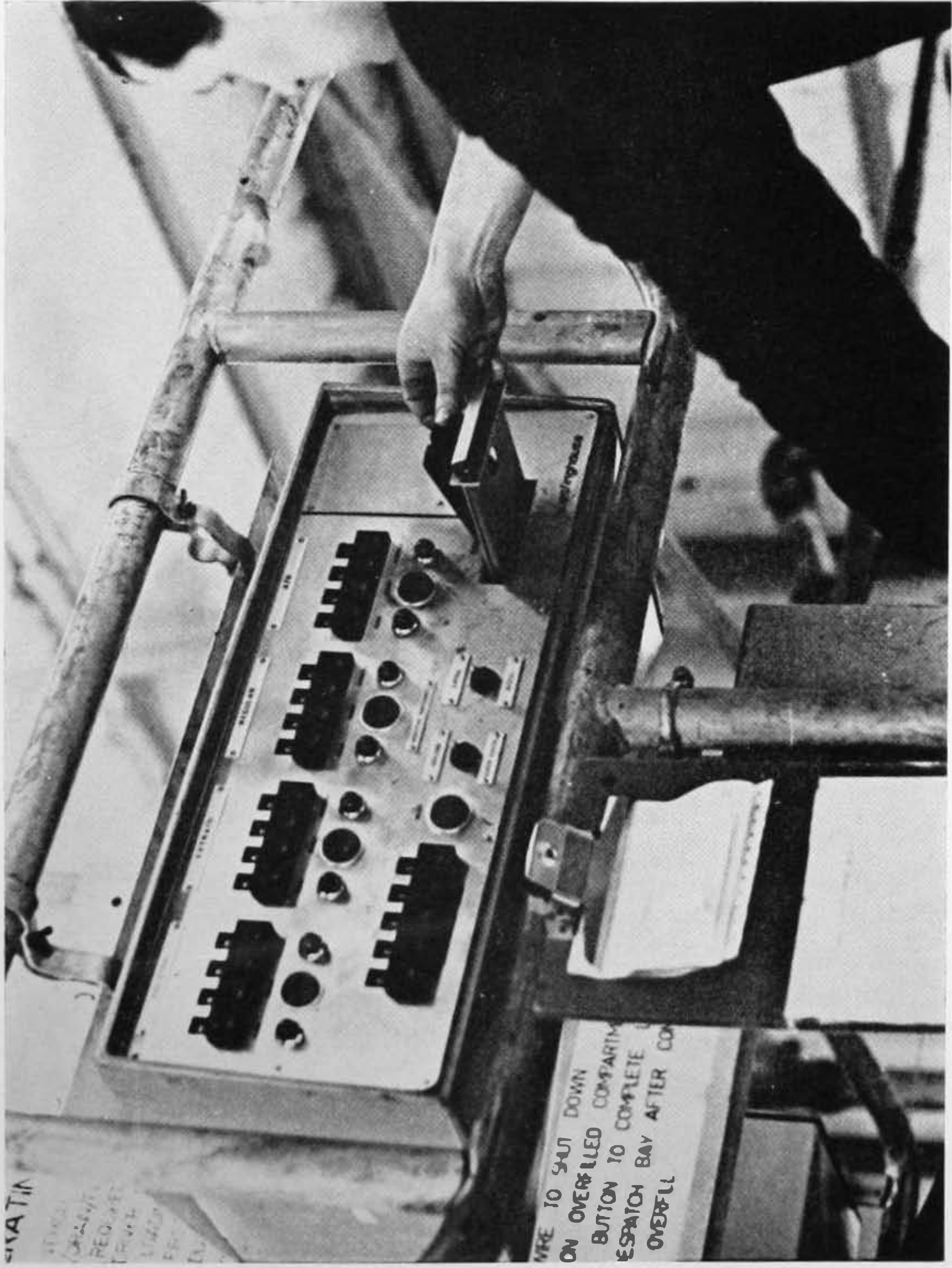


Plate No. 7

OPERATING INSTRUCTIONS

1. INSERT DRIVER CARD.
2. EARTH VEHICLE.
3. LOWER ARM INTO VEHICLE.
4. CHECK COMPARTMENT SIZE AGAINST PRESET QUANTITY.
5. SET UP LOADING AUTHORITY NUMBER.
6. PRESET QUANTITY - (CHECK ADDITIVE SWITCH).
7. PRESS "READY" BUTTON.
IF NO PRODUCT FLOWS WITHIN 30 SECONDS
CHECK - EARTH PLUG. LOADING VALVE.
"RESET" BUTTON. GATE VALVE.
8. REPEAT ITEMS 3.4.6 AND 7 FOR
REMAINING ARMS.
9. WHEN LOAD COMPLETE :-
 (A). REMOVE DRIVER CARD.
 (B). RAISE ARMS.
 (C). LOCK MANHOLE COVERS.
 (D). REMOVE EARTH PLUG.

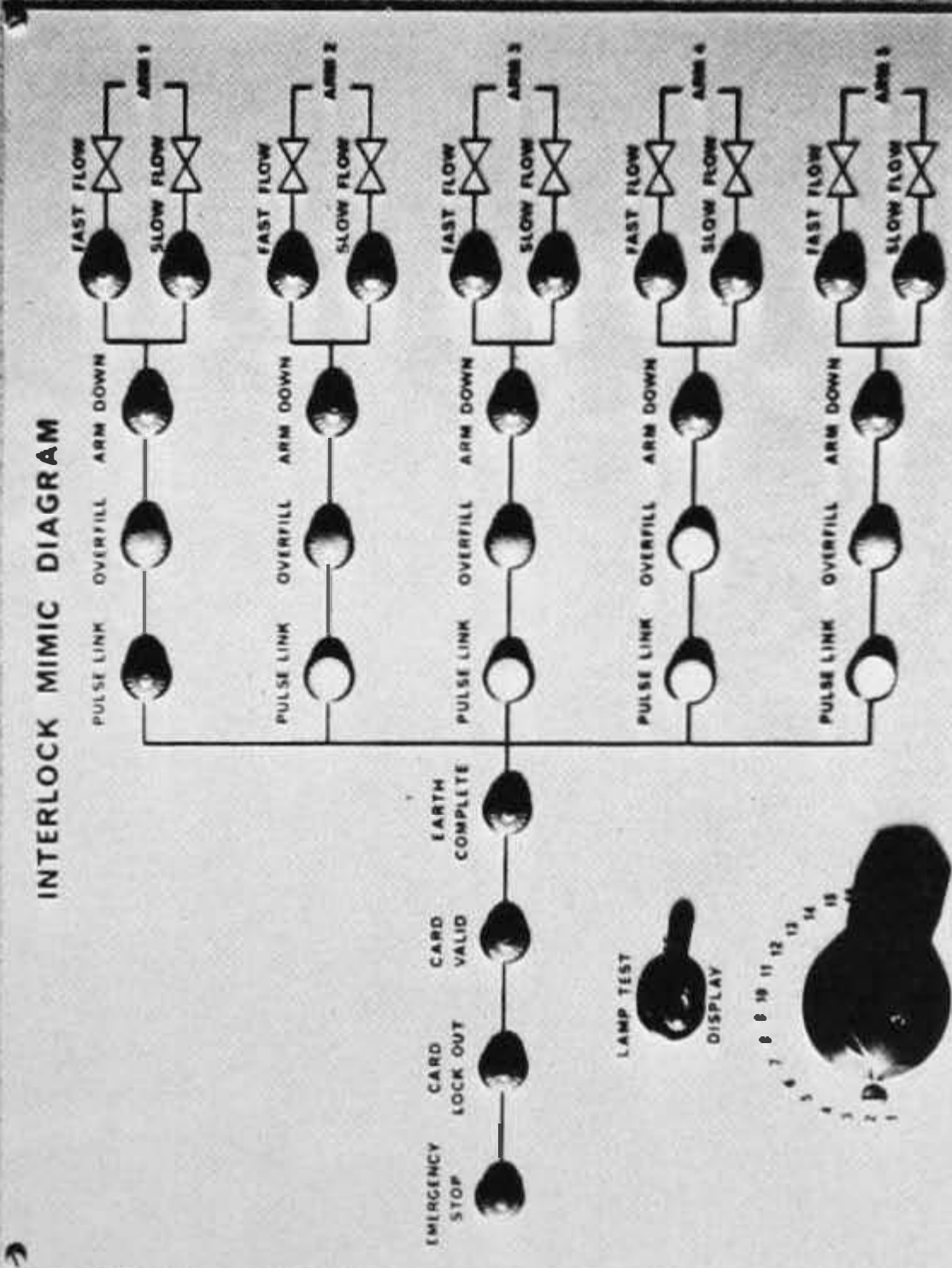
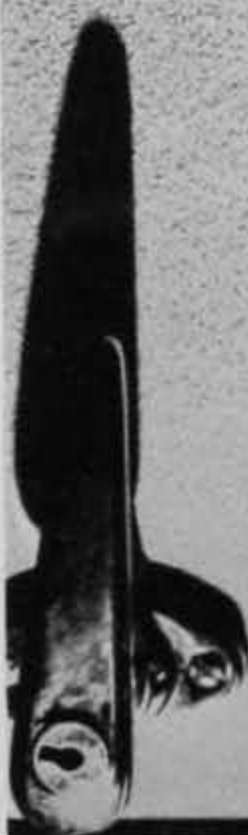
IF WRONG QUANTITY PRESET - EMERGENCY
STOP AND CONTACT SUPERVISOR.

OVERFILL

- I. FULL STOP WIRE OR CLOSE LOADING VALVE
TO SHUT DOWN.
- II. RAISE ARM ON OVERFILLED COMPARTMENT.
- III. PRESS "RESET" BUTTON TO COMPLETE LOAD.
- IV. REPORT TO DESPATCH BAY AFTER COMPLETION
OF LOADING ON OVERFILL.

UNDERFILL

REPORT TO YARD SUPERVISOR.



UPSTAIRS
DOWNSTAIRS



Plate No. 10

WARNING

LOADING ARM VALVE

**MUST BE CLOSED
BEFORE OPERATING
SWITCH**

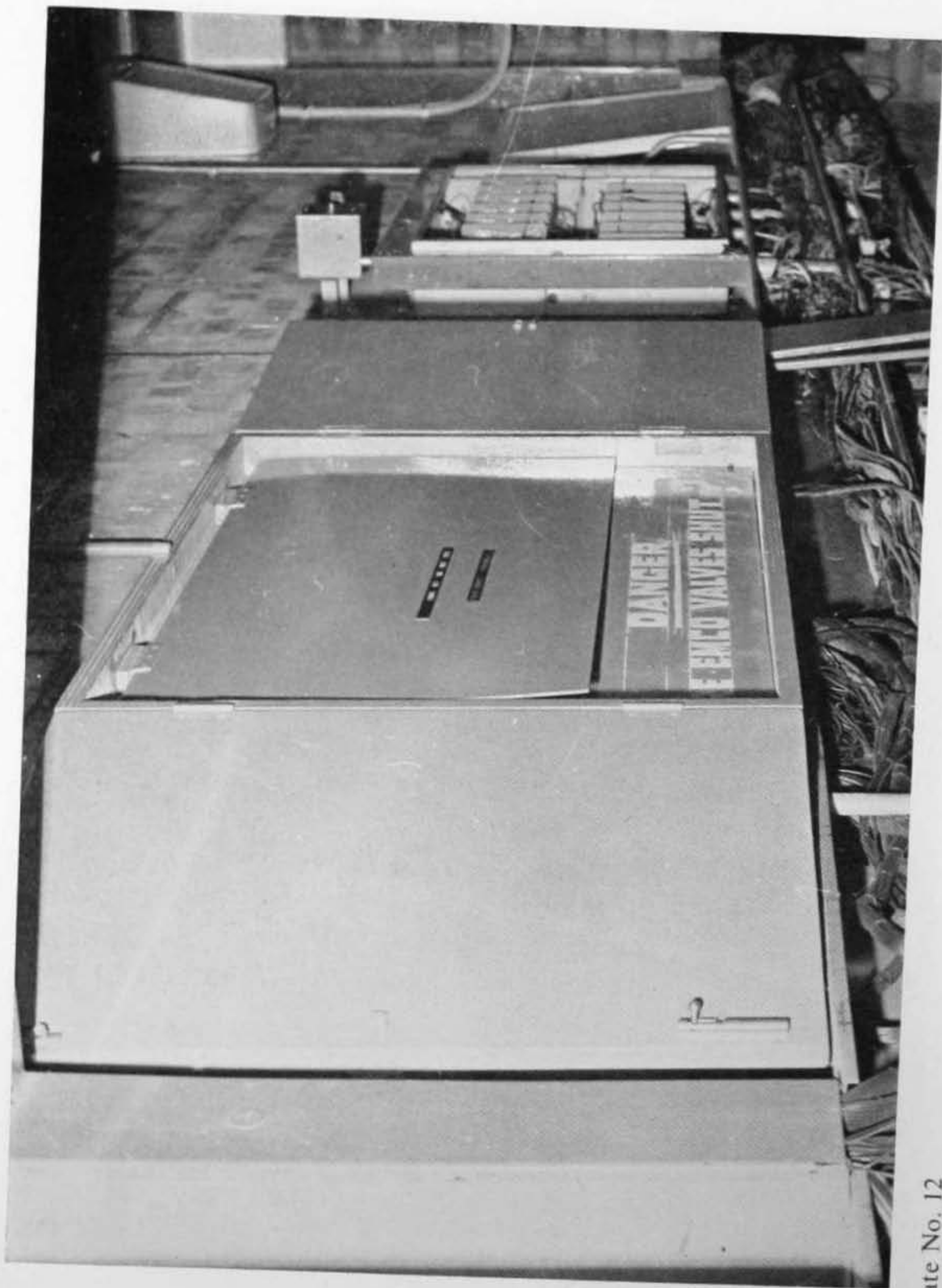


Plate No. 12

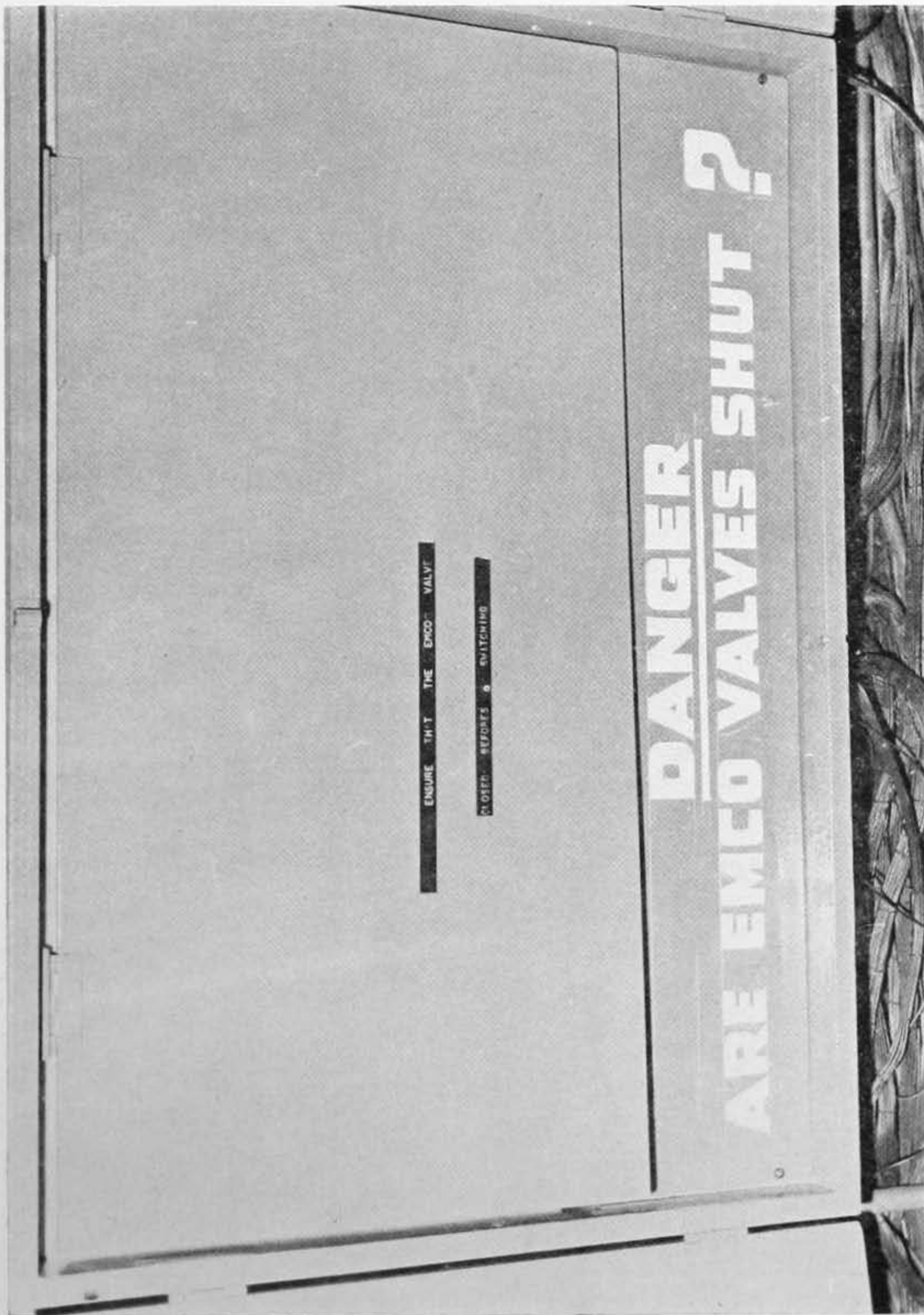


Plate No. 13



Plate No. 14



Plate No. 15

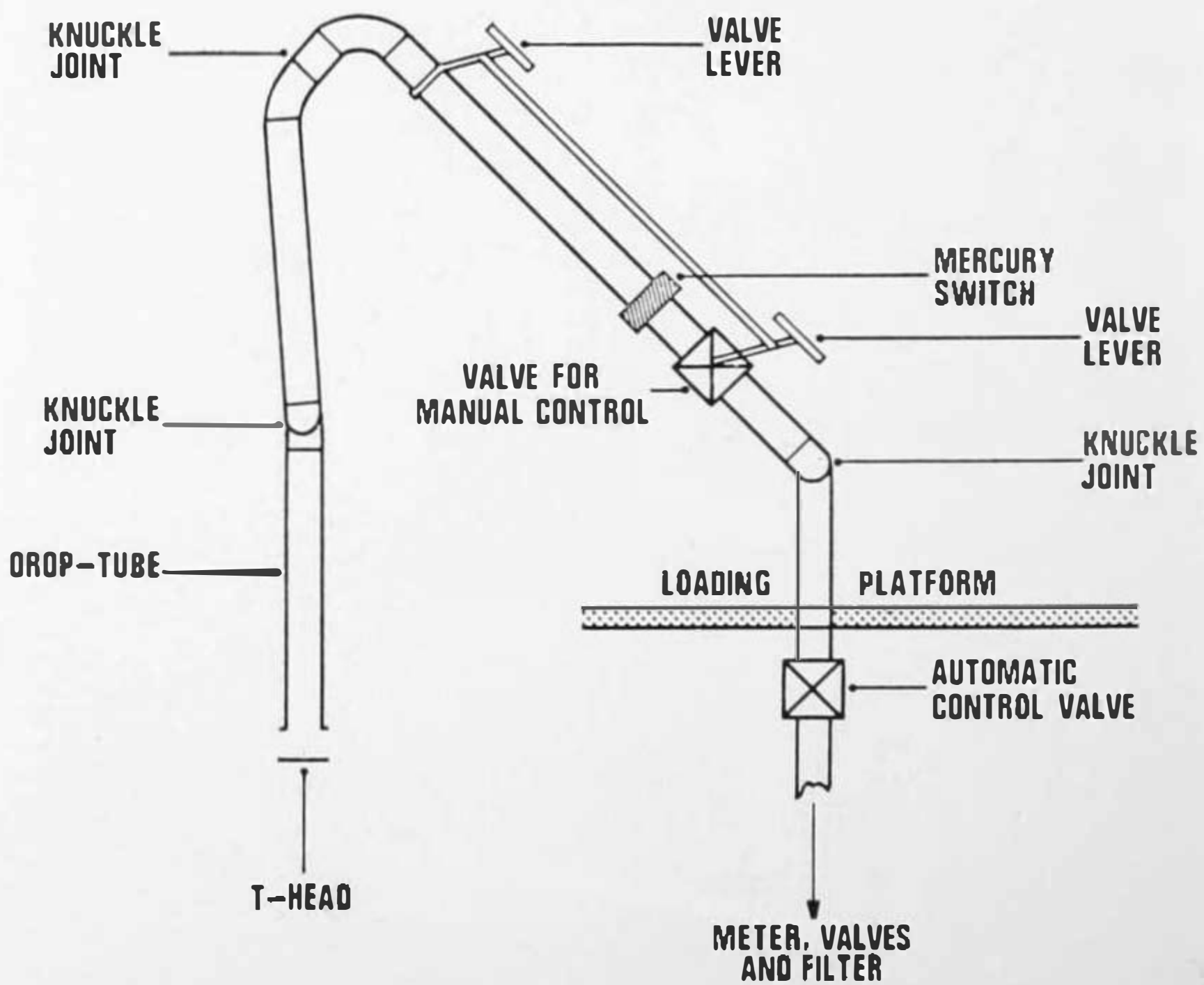


Figure 1

Recommendations

I recommend that:

1. the Esso Petroleum Company Limited, should take a close look at the general safety measures, including fire-protection and fire-fighting, at the West London Terminal, bring them up to a fully acceptable standard, and take such measures as will ensure that they are enforced;
2. the Company should examine in detail the safety measures incorporated in their automatic loading system and should satisfy themselves that they are adequate and cannot be defeated by operational circumstances, before the system is taken into use again; they should examine whether the system itself is yet in a sufficient state of development;
3. the Company should institute a proper training programme for its personnel and admit to control of the plant only those who are adjudged proficient;
4. an operations and fault correction manual should be prepared and issued to all staff;
5. the design and lay-out of the loading facilities and services should be thoroughly scrutinised and such changes made as will lead to greater safety in operations;
6. the whole of the loading operations should be gone into, and changes made where necessary, in order to ensure that proper safety precautions are observed;
7. the loading procedure should be examined in order to determine whether rates of loading and extended automatic control have not now exceeded the bounds of what might reasonably be considered to be safe;
8. only vehicles known to be constructed in accordance with current regulations for petroleum-spirit should be allowed at any set of stands, other than one exclusively devoted to dispensing high flash-point products;
9. some system of regular supervision of operations and regular inspection of equipment and services should be instituted in order to maintain proper safety standards.

Acknowledgements

I acknowledge with grateful thanks the advice and assistance rendered to me during the course of this inquiry by the Electrical Adviser to the Home Office, by Dr. R. M. H. Wyatt of the Explosives Research and Development Establishment at Waltham Abbey and by my colleagues Dr. H. A. Mayes, Mr. D. W. M. Staples, Mr. J. Blythin, Mr. W. McCarthy and Mr. Martin Jones.

I record with pleasure the unfailing help given to me at all times by personnel of the Esso Petroleum Company Limited; my thanks are also due to the Company for the plates and plans which are embodied in this report. I acknowledge with thanks Plate No. 15 from the Commissioner of Police of the Metropolis.

H. K. Black

H.M. Chief Inspector of Explosives

APPENDIX I

FIRE FIGHTING OPERATIONS AT ESSO WEST LONDON TERMINAL, BEDFONT ROAD, STANWELL

1st April, 1967

Fire protection installations and equipment

The fire protection of the premises is based, principally, upon a system of fire mains and associated fixed pumps, serving both hydrants and tank drenchers. This installation (see Annexe), together with a stock of foam compound and a number of foam generators, is considered to be a reasonable provision by the Company, regard being paid to the low surrounding fire exposure hazard and the existence of additional water supplies in the vicinity which the fire brigade can bring into use by means of water relay operations.

There is also a provision of portable fire extinguishing appliances.

An electric bell fire warning system is installed which can be operated from any of several positions at the buildings, on the loading stands and elsewhere on the site.

Fire-fighting at the time of the accident

Many of the persons upon the site, particularly tanker crews who were about to leave the canteen building to return to the loading bays, either saw or immediately became aware of the start of the fire, and observed the rapidity with which it spread to involve nearly the whole of the landing stands and the tankers in the bays. Witnesses said that this unique and terrifying experience caused a number of them to seek safety by attempting to scale the "unclimbable" boundary fence; some actually succeeded in so doing, and a few minor injuries were suffered in the process, while others made their way towards the gates or, recovering from their first shock, returned to help.

It appears that, in consequence, there was no organised attempt to assist at this early stage. Nevertheless, the evidence indicates that those who remained on hand not only did all that may have been possible to aid the four men who had been severely burned at the loading stands, but also undertook other emergency action. In view of the stress under which all concerned were acting, it has not been possible, from their evidence, to determine the time and sequence of events, nor to establish which actions by individuals were taken on their own initiative or in response to directions from the Shift Supervisor, who appears to have acted most creditably in difficult circumstances, or from any other senior person. The fact remains that the public fire brigade was called, the depot fire pumps were started, the gates to the fire access road were unlocked and opened, the doors to the terminal fire station were opened, and various valves on the product lines were shut down as a precaution. Also, two tankers were driven to safety from Bays Nos. 17 and 18.

Action by London Airport Fire Service

An explosion was heard at the fire station at London Airport, and on being informed of the fire from the Control Tower, the Airport fire officer responded to the Terminal with three appliances and twelve men. Since this deployment

would have unduly reduced the Airport fire cover, he asked his headquarters to request the London Fire Brigade to provide stand-by cover during his absence.

The shortest route over the Airport necessitated crossing two runways in use and this was accomplished by arrangement with the airport control tower by radio.

On arrival at the fire, the Airport fire officer concluded that the fire on the loading stands was not likely to spread further, but there was also a tanker which had moved forward from a loading bay and was burning near to pipe lines. He therefore positioned one appliance where it was possible to sweep the loading bays with a super foam jet, and applied his further resources to dealing with the tanker, which, following another explosion, moved forward again and straddled a track of five pipelines.

The airport fire appliances, with a foam production capacity of 7,000 g.p.m. were eminently suitable for the Terminal fire and, therefore, the fire officer decided not to withdraw his men and machines, as would normally have been done, when the public fire brigades arrived soon afterwards.

Action by public fire brigades

There was no delay in the calling of the fire brigade or in the fire brigades attendance in response to the call. The predetermined attendance for the West London Terminal is seventeen appliances (9 Surrey Fire Brigade; 8 London Fire Brigade) and this attendance was despatched, the first two appliances arriving from Staines fire station at approximately 07 42 hours.

The fire situation at this time appears to have been as described by the London Airport fire officer with nearly all the loading bays involved and the separate tanker fire. The Sub Officer in charge did not see any of the injured but was told by others on the site that there had been injuries, and that the persons concerned were being taken away by ambulances; he, himself, saw an ambulance.

Having immediately instructed his crews, the Sub Officer spoke to one of the Terminal Engineers, whom he knew by sight but not by name, and ascertained from him that the flow of product to the loading stands had been shut down. Asked whether the terminal fire pumps had been started, the Engineer said that he would check and he later reported that the pumps were running.

The officer in charge of the London Airport appliance which was engaged in dealing with the burning tanker athwart pipelines, told the Sub Officer that they were having difficulty in getting water, and the Sub Officer therefore directed some of his men to run twin hose lines from one of the hydrants to feed the Airport appliance and enable it to sustain the application of foam.

By this time, other appliances and more-senior officers were arriving and the attack upon the fire was being developed. A Divisional Officer from Surrey arrived at 07 53 hours and took charge of all subsequent operations. A water relay from an open supply north of the Terminal was already being set-in to supplement the Terminal water supplies and, at 07 57 hours, the Divisional Officer sent an assistance message "Make pumps 15". At one stage the water supplies were not fully adequate to meet the increasing use of water but, with the completion of relays, this was overcome and fires both at the loading stands and in the separate tanker were being brought under control. However, the Divisional Officer had the impression that some oil products were still flowing

at the loading stands and, at about 08 30 hours, he mentioned this fear to the Terminal Manager. Shortly afterwards the intensity of fire lessened and, at 08 40 hours, the "Stop" message was sent.

Observations

Generally speaking, no unusual fire-fighting difficulties were experienced in dealing with this fire; its extinguishment in approximately one hour is regarded as very satisfactory. A copy of the fire report form (K.433) shows that a total of 27 appliances attended and that 13 foam streams were used for extinguishment.

There are, however, a number of points emerging from the inquiry on which the following are my observations:

Fire instructions and fire training

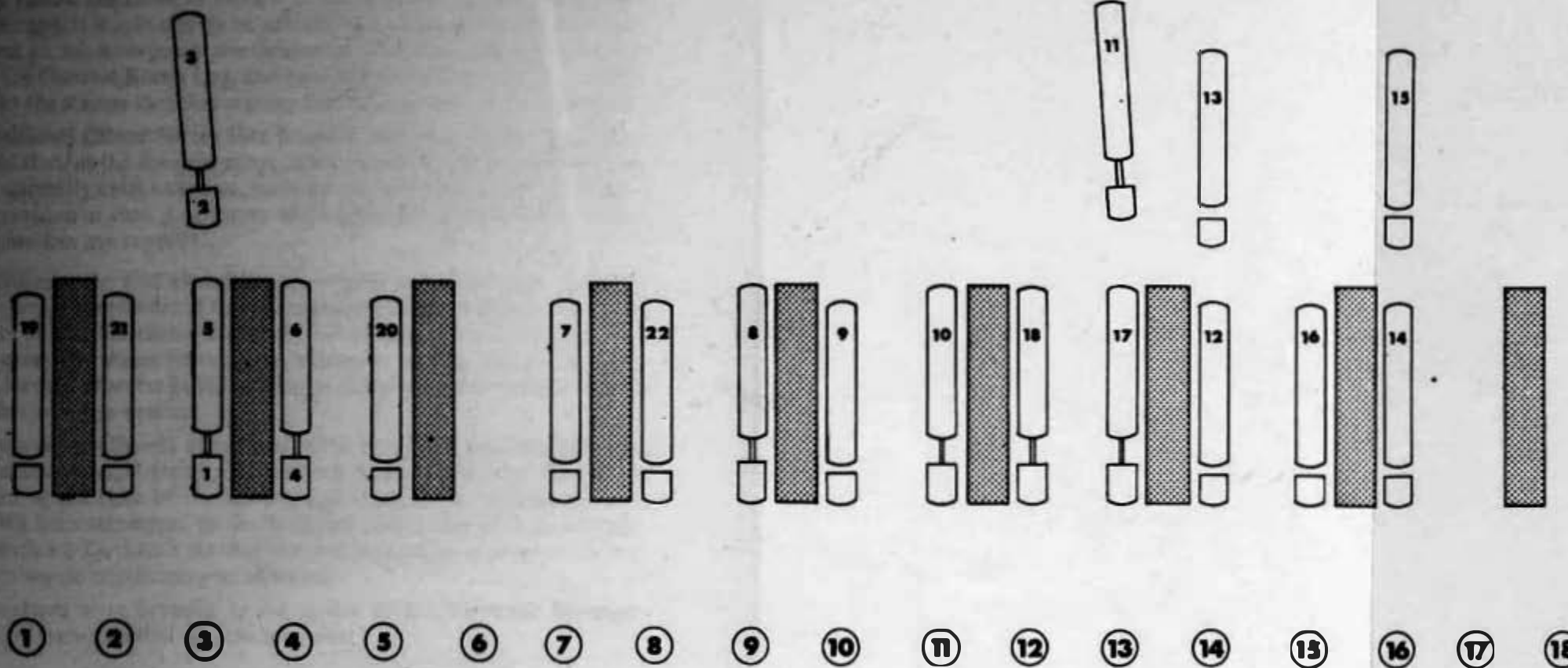
1. A file copy of typewritten "Fire Precautions", dated the 19th April, 1966, was produced which detailed what should be done by a person discovering fire or hearing the fire alarm. It was also said that fire instructions had been exhibited on the notice boards adjacent to men's locker rooms, but no such general instructions were observed in any part of the office building. Some witnesses denied ever having seen fire notices displayed; others thought that they had seen them but had only a very inadequate understanding of the fire routine. It would be preferable for printed fire notices to be permanently displayed on a separate board and not included with a miscellany of staff notices.
2. Arrangements are in force with Surrey Fire Brigade whereby local crews visit the site for exercises and some members of the Terminal staff co-operate. I regard such exercises as a valuable means to familiarise members of the fire brigade and company employees with the nature and layout of the premises, and the fire-fighting facilities available, and there is no doubt that on the occasion of this fire members of the brigade benefited from earlier visits to the Terminal. However, other more general training is advisable for the Terminal staff to ensure that they have a clear understanding of their duties pending arrival of the fire brigade.

The Maintenance Supervisor has overall responsibility for the fire protection arrangements at the Terminal, and a member of the staff is understood to have been appointed as Training Officer but is said to be himself waiting to attend a course of instruction; in the meantime it appears that no programme of training has been begun. The kind of training required would not be extensive, but it needs to be placed on a proper basis and recorded to ensure that all persons are included from time to time.

Maintenance of fire protection installations

3. Maintenance of the fire protection installations (not portable extinguishing appliances) is undertaken by Terminal staff and is a responsibility of the Maintenance Supervisor.

At the time of the fire the switches for remote starting of the fire pumps were out of commission due, it is believed, to cable damage caused some days previously by contractors on the site and as a result, it was necessary to send men some 500 yards to start the pumps by hand. It has not been



VEHICLES		
Bay No.	Livery	Fleet No.
1	Monkton	95
2	"	66
3	"	177
Rear of 3	"	179
4	"	174
5	Oil-Heat	-
6	Vacant	-
7	Manchester	-
8	Esso	4490
9	"	4882 T3885
10	"	8009
11	"	9096 T3145
12	"	4474 T3770
13	"	4361 T2012
Rear of 13	"	4350 T3255
14	" "	0094
Rear of 14	Oil-Heat	-
15	Esso "	0088
16	" "	0089
Rear of 16	" "	0100

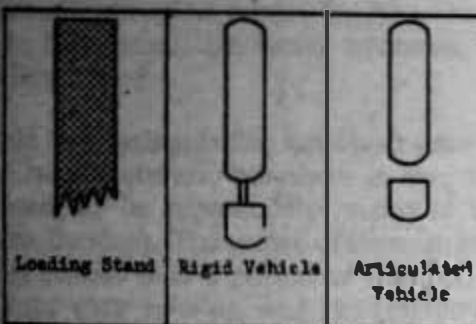
POSITION OF VEHICLES AT THE LOADING STANDS AT THE TIME OF THE FIRE

VEHICLES ON
10' RAILS FROM
MESSRS. MONKTON

Figure 2

NOTES.

1. The numbers surrounded by circles indicate the Bay numbers.
2. The numbers shown on the vehicles indicate the Home Office ref. Nos.
3. When the fire started there were vehicles at Bays 17 and 16. However they were driven away from the area and were not damaged.
4. The vehicle indicated as standing at Bay No. 2 moved away from the Loading Area during the course of the fire and came to a stop straddling the pipe-track leading from the terminal to Esso's Perry Oaks and London Airport Central Area Depot.



shown at what stage this was done. The reported difficulty of an Airport fire crew in obtaining water soon after their arrival may well indicate that the fire mains were not then pressurised; this has not been established, however, and, in my opinion, the course of this fire would not have been in any way affected by such temporary hindrance.

On any future occasion of failure of the remote starting equipment for the fire pumps, it would clearly be advisable to ensure that all who might be concerned in an emergency are informed, that the defect is at once recorded in the Control Room Log, and possibly elsewhere, and that a label is attached to the starter switches stating that manual starting is necessary.

The Divisional Officer Surrey Fire Brigade, who had charge of this fire, has suggested that, as the fire pumps are situated near to the point where the fire brigade normally enters the site, some visual indication, such as a light, should be provided at that position to show when the pumps are running. This suggestion has my support.

4. During the inquiry, the first available opportunity was taken to inspect the fire hydrants and it is considered that the standard of maintenance was poor. The hydrants on the fire mains are of the pillar type, with double outlets, and in two cases the sluice valves were letting-by so that the pillars each contained a column of water liable to become frozen in cold weather. There were a number of other defects.

There was an insufficient number of valve keys for operating hydrants and tank drenchers in the vicinity of the tank farm. Some keys may have been removed at the time of the fire (though there is no evidence of fire-fighting having been attempted by the Terminal staff); they should certainly have been restored forthwith so that the fire protection arrangements for the tank farm would continue to be effective.

These matters were brought to the notice of the Terminal Manager who forthwith instructed that they be remedied.

5. It was seen that, in some cases, both the outlets on a hydrant were controlled by a single valve. This is a bad arrangement because it necessitates closing down both outlets in the event of its being necessary to close either—for example, to replace a burst length of hose or to make some other adjustment to hose lines. On future hydrants, therefore, each outlet should be separately valved.
6. Portable fire extinguishing appliances are maintained on a contract basis by the manufacturers, but there is also a Terminal arrangement for this equipment to be superficially inspected by the Plant Supervisor once a week (on Sunday). The record of these inspections was produced and showed only six entries over a period of eighteen weeks; in some cases dates and signatures were missing, and the impression gained is that the matter is treated in a slipshod way.
7. Fire blankets are understood to have been available at the premises but not used for the extinguishment of the clothing of the men who were burned. It is for consideration whether a suitable provision should not be made nearer to but not actually on, the loading bays.

8. Fire Brigade access

A special access road from Short Lane to the south end of the site has been provided as part of the fire defence scheme originally planned in consultation with the fire brigade (then the Middlesex Fire Brigade).

One witness told of his having driven a tanker off the site by this road in order to reach safety. He did not, in fact, encounter any fire brigade appliances arriving but it is apparent that, had any appreciable number of tankers been removed by this route, there would have been the serious risk of the fire brigade being impeded. Instructions to drivers should prohibit use of the road and, if there would be any risk of the instruction being disregarded a guard might be posted at time of emergency.

9. Short Lane, which leads to the access road, was closed by the police who, at a comparatively early stage, placed posts across and a notice, "Police Accident". The Police did not, however, station a member of the force at this point to allow the fire brigade to pass and, in consequence, a number of machines were diverted to the main north entrance. Not only did this involve a small detour but, had a Control Point been established at the South gate, some loss of control may well have been caused.

Conclusions

There have been no reports from the fire brigades of any serious difficulties or deficiencies; indeed, it appears that the fire was brought under control quickly and efficiently.

The circumstances of the outbreak were such as might well cause some confusion and alarm on the part of Terminal staff and tanker crews on the site, but my impression is that better instruction and training with regard to a fire emergency would have contributed to more orderly action. It seems fortunate that some of the items mentioned in the foregoing 'Observations' did not have most serious consequences. There is need for a general tightening up of the fire defence arrangements, and it is desirable that this should be tackled urgently and that top management should show its concern for improvement.

ANNEXE

ESSO WEST LONDON TERMINAL FIRE PROTECTION INSTALLATIONS

Water supplies

Two fixed diesel pumps each of 1,500 g.p.m. capacity, draw water from a nearby unlimited open supply (a disused gravel pit) and feed through a 10 ins. diameter pipe to 8 ins. and 6 ins. diameter ring mains. Provision has been made for remote starting of the pumps from switches in the Control Room in the office building, about 500 yards away.

The ring mains serve eighteen double-outlet pillar hydrants some of which have only a single control valve located at the top of the pillar but, in most instances, there is both an underground sluice valve and separate control valves for each outlet.

In the vicinity of the tank farm, branch mains are connected to the ring mains to serve tank drenchers and each is valved at a position outside the bund.

There is also a 3 ins. diameter portable water main supplied from the water undertakings system which serves two hydrants in the vicinity of the office building. On test, this main has produced a maximum yield of about 180 g.p.m.

Foam stocks

The Terminal holds a stock of 5,000 gallons of foam compound of which 3,000 gallons are carried in a bowser, 400 gallons in each of two trailers and 1,200 gallons is in cans.

A number of foam generators and foam-making branch pipes are also available on the site.

COPY OF SHEET FROM TYPEWRITER 1.4.67

APPENDIX 2

TIME	DRIVER CODE	BAY No.	EXTRA	REGULAR	GOLDEN	A/D	L.S.G.O.	H.S.G.O.	GREEN	BLUE	W.S.	DIST.	R.D.	
03.49	405	02								5- 0		3- 0	2-4000	46
04.00	436	02								5-3800		3- 0	2- 0	0
04.03	435	13	2- 500	3- 0	1- 0	4-3000								
04.12	433	06	2- 0	3- 0			1- 0	4-1500 +						
04.17	433	10	2- 0	3- 0				4-1500 +						
04.18	433	10	2- 0	3- 0				4-1500 +						
04.27	433	10	2- 0	3- 0				4-1500						
06.33	117	18	2- 0	3- 0	1- 400	4- 0								
06.34	129	16	2- 200*	3- 200	1- 400	4- 0								
06.34	429	03					4- 0					3- 0	2-300 - 44	44
06.42	018	15	2- 780	3-1261	1- 360	4- 0								
06.43	117	18	2- 800	3- 360	1-1240	4- 0								
06.45	429	03					4- 0					3- 0	2-3200	41
06.46	147	14	2-1061	3-1341	1- 800*	4- 0								
06.51	126	17	2-1600	3-1320	1-1080	4- 0								
06.55	153	15	2- 900	3- 600	1- 900	4- 0								
06.58	160	16	2-1100	3- 400	1- 0	4- 500								
07.07	058	16	2- 0	3- 0	1 0									

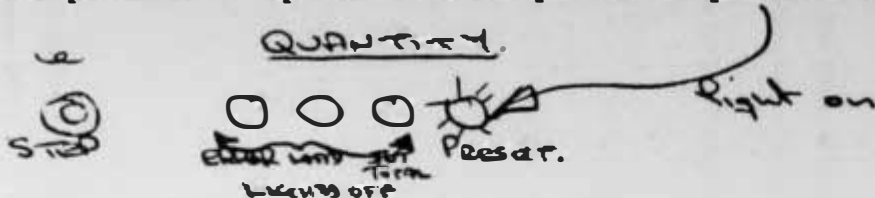
Figures marked + typed in red ink.

Figures marked + typed in red ink.

POSITION OF BUTTONS SHOWN ON ATTACHED DRAWING

To Clear Pre-set Down:-

- 1) Set to Manual. (Bottom left hand corner, white key)
- 2) Set pre-set lamp on left of panel to pre-set ~~ON~~.



- 3) Press word button to set word 3.
- 4) Press arithmetic cycle sub-programme button until 'Step 8' is reached immediately after stopping past 8. Return Manual/Normal switch to Normal.

When Stuck on Arithmetic Cycle:-

Put switch to manual, stop meter to meter 5, stop again at the same time. return manual/normal switch to normal. This will probably bring up printer access - demand I.T. to clear down.

When Typewriter Fault:-

Switch to manual (bottom left-hand corner white key up). Press bottom right-hand corner black button until all lights adjacent to this button are ON. Press once more when all lamps will go OFF. Press once again and immediately return to Normal. While doing this operation, inform all Drivers NOT to insert, or withdraw, cards or pre-set. If they do, see above.

FAULT SYMPTOM

If the Driver on a Bay has:-

- 1) Earthed his vehicle,
- 2) Put his card in the drawer,
- 3) Lowered the required loading arm,
- 4) Set up the correct amount to be loaded,
- 5) Pressed the ready button,

and reports that he cannot obtain product, see if the relevant mimic panel lights with respect to the arm being used are on EXCEPT the valve high and low lights situated on right-hand-side of panel. If this is the case:-

Check that the Red 'Bay Parity' light on that Bay is on. If the red light respective to that Bay is on then either:-

- a) the Driver has not put his card into the drawer properly; this can be checked on the mimic panel, or
- b) the push button switches on that Bay's pre-set head have operated incorrectly. This is not a Driver fault. The audible alarm signal accompanies this fault.

Cure:-

To overcome this Bay Parity, state request that the Driver remove his card and replace it correctly in drawer.

The printer will now give a print-out. An audible alarm is raised when the card has been inserted, or when the switches were being pre-set. After completion of print-out the Driver should be requested to rotate switches a number of times.

ALARM

ALARM NO. 0 0 0 0

0

ALARMING UNIT

WATER No. 4 2 1

QUANTITY

0 0 0 0 0

WATER

4 2 1

SUB PROGRAM

0 0 0 0

ACCUMULATOR

0 0 0 0

ARITH

0 0 0 0

ADD CARRY

POWER OFF

ON

STOP

LAUNCH

ADC

HUNDREDS 0 0 0 0 8 4 2 1

TENS 0 0 0 0 8 4 2 1

UNITS 0 0 0 0 8 4 2 1

STORE

BAY ADDRESS 0 0 0 0 0 0 0 0 0 0 0 0

QUANTITY 0 0 0 0 0 0 0 0 0 0 0 0

INFORMATION UNIT

0 0 0 0 0 0 0 0 0 0 0 0

INFORMATION IN

0 0 0 0 0 0 0 0 0 0 0 0

CONTROL

0 0 0 0 0 0 0 0 0 0 0 0

STORE ACCESS SCANNER

0 0 0 0 0 0 0 0 0 0 0 0

PRINT STOP

0 0 0 0 0 0 0 0 0 0 0 0

PRINTER

0 0 0 0 0 0 0 0 0 0 0 0

COLUMN No

0 0 0 0 0 0 0 0 0 0 0 0

SUB PROG

0 0 0 0 0 0 0 0 0 0 0 0

DATE BAY NO DRIVER CARD

TIME ARN No

DATA LOG, ALARM & INFORMATION PANEL.

METEOROLOGICAL OFFICE

APPENDIX 4

WEATHER CONDITIONS AT LONDON AIRPORT (HEATHROW) ON 1ST APRIL 1967

Time (GMT)	Wind		Visibility (yards)	Temperature (°C)	Relative Humidity (%)	Cloud		Weather
	Direction (degrees)	Speed (knots)				Amount (eighths)	Height (ft)	
0615		CALM	550	-2.2	98	3	25,000	Fog
0645		CALM	2190	-1.2	95	4	25,000	Mist
0715	300	04	3060	-0.6	93	6	25,000	Mist
0745	310	03	3280	+0.3	84	6	25,000	Haze

Wind direction given in degrees from North, viz:- W = 270°, NW = 315° and N = 360°.

Temperatures are taken from a thermometer exposed in a louvered screen 4 ft. above short turf.

All times are GMT, add 1 hour for British Summer Time.

I hereby certify that this information has been correctly transcribed from documents in the possession of the Meteorological Office.

To:- The Manager
Engineering Department
Esso Petroleum Company Ltd.
Victoria Street
London S.W.1.

Signed E. H. J. Rogers
Date 17 April 1967
Reference M 22839/62/Met O 3b
Meteorological Office,
London Road
Bracknell
Berks.

Reference ES/CW

REPORT OF INSPECTION OF ELECTRICAL EQUIPMENT
at
WEST LONDON TERMINAL, STANWELL,
of
ESSO PETROLEUM CO. LTD.
FOLLOWING A FIRE ON 1st APRIL, 1967

Description of Installation

The installation consisted of nine "stands", each being capable of accommodating a vehicle in a "bay" on each side, the total capacity at one time therefore being 18 vehicles in 18 bays.

Each stand was provided with cable terminating arrangements common to both bays. Each bay was fitted with product loading arms up to a maximum of five in number. The flow of product was controlled by two Wayne-Smith solenoid-operated valves on each supply pipe, one for full-rate and one for reduced-rate of flow. The jointed product arms were fitted with mercury-type level switches, to prevent flow of product unless the arm was in the lowered position. The product quantity in gallons was measured and was transmitted electrically by Jiskoot pulse transmitters (one per product pipe) to the control room.

Each bay was provided with a panel for selecting and controlling automatically the flow of product as required. Up to five product supply arms could be in use simultaneously for one vehicle.

The electrical equipment common to each stand (two bays) consisted of:—

- 1-Simplex flameproof cable terminating and junction box for 24 volt 3-phase 50 c.p.s. supply for the Jiskoot pulse transmitters. Also intended for operation of alarm bells, but this facility not yet provided (wiring not installed).
 - 1-Simplex flameproof cable terminating and junction box for 240 volt 3-phase 50 c.p.s. supply for solenoid valves for product and for solenoid air valves for additives (the latter valves not provided on all stands).
 - 1-Non-flameproof cable terminating and junction box for intrinsically-safe circuits concerned with preset heads.
 - 2-Non-flameproof cable terminating and junction boxes for fire alarm system.
 - 1-Emergency stop button (to shut down all pumps).
- Flameproof solenoid-operated Maxseal additive valves on certain stands.

Electrical equipment for each bay was as follows:—

- 2-Wayne-Smith flameproof solenoid-operated product valves for each product line.
- 1-Mercury-type level interlock switch on each product arm.
- 1-Jiskoot pulse transmitter per product line.
- 1-Earthing plug on flexible pre-coiled cable.

1-Flameproof lighting fitting (Victor Products Ltd. twin tube 80 watt per tube weatherproof fitting for Group II wired in mineral-insulated metal-sheathed cable).

(Note: Lighting switches were in the despatch department. None on stands.)

1-Product selection control panel (intrinsically-safe).

Cable arrangements

A common cable trench ran beneath the stands from end to end of the installation. This trench was connected by two trenches to the switchroom on the other side of the yard.

Power and control cables from the switchroom to the stands were of wire-armoured type with P.V.C. covering overall. Outgoing cables from the terminal boxes on the stands were generally of mineral-insulated metal-sheathed type.

A manhole with cast-iron cover was provided on each stand to give access to the common cable trench.

Inspection

A detailed inspection was made of the electrical equipment of each stand and each bay. This consisted of inspection of each flameproof item, if not too badly damaged, for tightness of cover studs, cover flange gap clearance (if any), and tightness of cable glands. Items were opened for internal inspection when it was found that any looseness of cover studs was present.

All items seen (excluding cables) were either of certified flameproof or certified intrinsically-safe type. All cables, except the flexible earth interlock cables, were of wire-armoured or metal-sheathed type. The earth interlock cables were of rubber or plastic insulated pre-coiled type.

In the following notes on inspection, items not noted as faulty may be taken as being in satisfactory condition as regards maintenance for flameproofness, or as being so damaged, destroyed or detached as to make inspection from this point of view impossible.

Notes on inspection

Stands .. 1-9 inclusive, 9 total.

Bays .. 2 per stand, 1-18 inclusive, 18 total.

Stand 1 Flameproof junction box (1) .. 24 volt.

1-Pyrotanax olive nut $\frac{1}{8}$ turn loose.

Gland nuts loose on incoming cables (probably due to melting of lead washers).

Flameproof junction box (2) .. 240 volt.

1-Cover stud $1\frac{1}{2}$ turns loose. (Gap between cover and box less than 0.004 in.).

1.25" diameter bottom plug loose but engaged for depth of 0.75" (9 threads). Plug length 1.25".

Gland nuts loose on incoming cables (probably due to melting of lead washers).

Bay 1 .. Flameproof Solenoid valve—1 cover nut slightly loose.

Bay 2 .. Fire alarm box—I-cover screw missing. (Box contains intrinsically safe circuits.)

Bay 2 .. Platform—Flushing hose earthing unit—I-screw missing from I.S. cover.

Note: Fire damage was severe on this stand.

Stand 2 No defects noted.

Fire damage not very great.

Stand 3 Flameproof junction box (1) ... 24 volt.

1-Pyrotenax cable olive nut not engaged.

3-others loose.

All cover studs slightly loose.

Cover removed. No signs of electrical flashover inside, but evidence of heat damage to drier bag and PVC terminal number tags.

Bay 5 .. Some cable gland nuts missing.

Bay 6 .. Solenoid valve flameproof junction box—I-cover stud of 4 missing.

Box opened. Much heat damage inside but terminals tight.
Brass gland nuts melted.

Note: Severe damage by heat to this stand.

Stand 4 Flameproof junction box (1) .. 24 volt

Flameproof junction box (2) .. 240 volt

All studs on lids tight.

Gland nuts tight where cables not too badly damaged to check.

1-Wayne-Smith junction box missing (due to heat damage).

Bays 7 and 8 .. Except for fire damage, nothing noted.

Note: Much heat damage to this stand.

Many incoming cables badly damaged, and some burnt off completely.

Stand 5 Flameproof junction box (1) .. 24 volt

Flameproof junction box (2) .. 240 volt

All studs on lids tight.

Bay 9 .. 1-junction box for Wayne-Smith solenoid missing.

Note: Much damage by heat to incoming cables.

Stand 6 Flameproof junction box (2) .. 240 volt

2-studs on lid slightly loose.

Lid removed. Inside of box badly charred. Copper conductors and cable braiding intact.

No indication of internal fault.

Flameproof junction box (1) .. 24 volt

Lid removed. Condition similar to 240 volt box. Possible internal fault but no positive indication.

Bay 11 .. Meter No. 2—Wayne-Smith flameproof junction box on incoming side—one cover stud missing—flange gap over nearly half the circumference (i.e. 3" length) was 0.025" approx.

2-Wayne-Smith junction boxes missing.

Note: All incoming cables to this stand badly damaged by fire.

Stand 7 Flameproof junction box (1) .. 24 volt

Flameproof junction box (2) .. 240 volt

All studs on lids tight.

Bay 13 and 14 .. All cover studs tight where tests could be made.

Many Wayne-Smith solenoids burnt away.

Note: Much fire damage. Many incoming cables burnt off or damaged.

Stand 8 Flameproof junction box (1) .. 24 volt

1-Pyrotex cable gland with loose olive nut and no olive.

Note: Much fire damage to incoming cables.

Stand 9 Flameproof junction box (1) .. 24 volt

Flameproof junction box (2) .. 240 volt

Little damaged.

Bay 18 .. Olive nut on No. 3 interconnector Wayne-Smith solenoid junction box $2\frac{1}{4}$ turns loose. Gland nut tight.

Meter No. 2 Jiskoot terminal box having three cover studs. One stud with stripped thread. Flange gap 0.018"-0.020".

Lighting of bays

In most bays the flameproof fluorescent fittings at high level above the bays were damaged by heat and water and the glasses broken. The fitting in Bay 18 was inspected in detail, and was found to be undamaged and in satisfactory flameproof condition.

Cable trenches

Several of the manhole covers were lifted (on Stands 4, 5, 6, 7 and 9). The common cable trench was found filled with water to within about one foot of ground level, possibly as a result of the fire-fighting.

Electrical junction boxes, some of flameproof type, were seen on the walls of all manholes inspected. On Nos. 4 and 5 stands the boxes seen were partly submerged.

Information received from Messrs. Thompson and Hall was to the effect that no drains are provided for the trenches, and that the water level seen may be the water table level. The trenches are inspected and pumped out from time to time.

Conclusions

As originally installed, the electrical equipment on the stands and bays was suitable for the possibly hazardous conditions which might arise, being either of flameproof construction or intrinsically safe.

So far as could be judged in view of the fire damage, the state of maintenance had been satisfactory up to the time of the fire, with the following possible exceptions:

1. Stand 3 .. Pyrotenax cable nuts loose (1 not engaged).
2. Bay 6 .. 1-cover stud out of 4 missing from solenoid valve flameproof junction box. Gap not excessive.
3. Bay 11 .. 1-cover stud out of 4 missing from solenoid valve flameproof junction box. Excessive flange gap.
4. Stand 8 .. 1-Pyrotenax cable gland with loose olive nut and no olive.
5. Bay 18 .. Olive nut on Pyrotenax cable gland loose. 1-stud out of 3 on Jiskoot terminal box with stripped thread. Flange gap excessive.

While as a matter of routine all cover studs and cable gland nuts on flameproof apparatus should be kept tight, the loose items noted had resulted in flange gaps in excess of the permissible maximum value in only two cases. One of these occurred in Bay 18, where virtually no fire damage was evident. This fault can be ruled out as a possible cause of the general fire, as, apart from the excessive flange gap, there was no indication of damage, such as would be caused by flame emission, on the Jiskoot terminal box. The other excessive gap occurred in Bay 11, where one stud out of four was missing from a solenoid valve junction box. There was great damage by fire in this bay, but no evidence of emission of flame from the junction box was noted.

None of the flameproof apparatus enclosures on the stands or bays contained contacts which would cause sparking in normal operation. The apparatus contained only terminals, except the Jiskoot pulse transmitters, which contained reed switches which are themselves hermetically sealed in their individual enclosures.

It would therefore have been necessary for two faults to occur simultaneously on one item of flameproof apparatus in order to produce ignition of a surrounding explosive atmosphere, namely a loose and sparking connection or a broken and sparking reed switch, in conjunction with excessive flange gap.

Ignition could also have been initiated if a fault had occurred in any intrinsically-safe circuit resulting in excess current leading to sparking or arcing in the hazardous zone. All apparatus not rendered safe by flameproof enclosure was however of intrinsically-safe type, designed to prevent as far as possible the occurrence of the type of fault mentioned. No evidence was found to indicate that any such fault had occurred.

It is therefore considered unlikely that the fire was caused by ignition from any of the electrical apparatus on the stands.

Vehicles

Inspection was carried out of 20 road tanker vehicles consisting of 14-complete vehicles, either articulated or non-articulated, 4-articulated trailer (tank) units, and 1-articulated tractor unit.

Nearly all vehicles were badly damaged by fire. Inspection was directed to ascertaining whether all vehicles were wired on the two-wire system. Batteries and battery switches were inspected where possible, and also lampholders. In no case was an earthing connection seen on a battery, nor were any single contact lampholders noted.

It was noticeable that the starter motors on many vehicles had been severely damaged in the fire. Parts of casings and interiors evidently made of

light alloy had in many instances almost melted away, leaving only the steel shaft with starter pinion and spring.

As none of the electrical equipment on the vehicles was flameproof or otherwise safe for use in an explosive atmosphere if switching, breakage of a lit lamp, operation of the starter motor, or electrical fault in any circuit should occur during the time of exposure, initiation of a fire by these means cannot be ruled out. No positive evidence of such a cause was however seen.

EXAMINATION OF LIGHT ALLOY PIPE FITTINGS RECEIVED FROM DR. BLACK.

1. INTRODUCTION

Four samples of light alloy were received from Dr. H. K. Black, Chief Inspector of Explosives, Home Office on 21/4/67. The samples were as follows:

- (a) 4" diam. light alloy piping, approx. 5'3" long.
- (b) 4" diam. light alloy piping 4" long, attached to a steel collar or coupling, 4" diam. and 4" long.
- (c) 4" diam. light alloy piping approx. 13" long, partially melted at one end.
- (d) A variable dimensional mass of light alloy, which had been molten and subsequently solidified as plates.

E2 RARDE were requested to examine the effects produced by the impact between these samples of light alloy, and rusty iron or steel, with particular reference to the ability of this impact to ignite a hydrocarbon-air mixture.

2. TESTS

Items (a), (b) & (c) above were struck against rusty iron and steel surfaces. In all cases large sparks or flashes were produced in air.

The technique adopted for investigating ignitions of a propane-air mixture was essentially based upon the procedure which is in current use at the Ministry of Power, S.M.R.E. Buxton, where it is used to investigate ignitions arising from sparks in methane-air mixtures.* It consists of striking a rusty iron or steel anvil placed in a gas chamber which is filled with the appropriate gas-air mixture. This is very conveniently done by arranging the anvil inside a long narrow metal box which has a fully open top. This top is sealed by a diaphragm of cellophane and the gas mixture is introduced. Before sealing, a thin aluminium foil—such as used in cigarette packets—is laid on the anvil. Alternatively, the anvil can be "smeared" with aluminium from any convenient source. The smears or foil can then be struck, after puncturing the diaphragm. By this procedure S.M.R.E. obtain a high incidence of ignitions in the appropriate methane-air mixtures.

In our tests, a propane-air bunsen type burner was used to deliver a combustible mixture directly into the gas chamber, and the aluminium foil technique used for producing the aluminised layer on the anvil. With light or medium blows from a small steel hammer (10 ounce) large sparks were obtained and in one instance the gas mixture was ignited.

Further experiments were carried out in which the alloy specimens supplied by Dr. Black were used to smear the rusty anvil. Although large sparks and

*"The Ignition of Methane-Air by the Glancing Impact of Metals on Smears of Light Alloys formed on Rusty Surfaces", by Dr. D. Rae, June 1960.

flashes were obtained as a result of similar impacts on this surface, it was not possible to achieve further ignitions. The lack of further positive ignitions is thought to be mainly due to the inability of obtaining an initial strike by simple manual means in the correct place on the anvil, with particular reference to the inflowing gas mixture.

IF ARM OR BAY WAS

TO GO ON MANUA

1. CLOSE APPROPRIATE

BMCO LOADING VALVES

—H—

2. Open Gravity Valve Control

CABINET IN SWITCHROOM

USE

KEY

16

AND SWITCH APPROPRIATE

00-112

—H—

MANUAL

C PLACE ~~MANUAL~~ CLIP
OVER THOT ARMS
SWITCHES ON THE BAYS
PRESS HEAD.

2 IF BAY IS PUT ON
MANUAL *put* OUT OF
sign over press head

HOURS - 03, 09, 15 & 2100 GMT

AIR MINISTRY
Meteorological Office

APPENDIX 8

FREQUENCY OF WIND DIRECTION AND VELOCITY

at LONDON AIRPORT ANNUAL YEARS 1949-58

Lat. 51° 29' N Long. 0° 22' W Altitude 82 ft. above M.S.L.

Height of Vane or Cups

{ Above Ground 33 ft.
Above Building ft.
Effective Height 33 ft. No.

Mean Wind Speed			Degrees (true)												All Dir.
Beaufort force	Knots	M.P.H.	350-10	20-40	50-70	80-100	110-130	140-160	170-190	200-220	230-250	260-280	290-310	320-340	
0	0	0													10.1
1	1-3	1-3	1.2	1.1	0.6	0.5	0.3	0.4	0.7	0.7	0.9	1.2	1.1	0.8	9.5
2	4-6	4-7	2.1	1.9	1.4	1.4	0.8	0.9	1.5	1.6	1.9	2.7	1.9	1.3	19.4
3	7-10	8-12	2.1	2.9	2.3	2.5	1.3	1.4	2.5	3.6	3.4	4.6	2.7	1.7	31.0
	11-16	13-18	0.9	1.4	1.5	1.1	0.5	0.8	2.1	4.0	4.2	4.0	1.4	0.8	22.7
5	17-21	19-24	0.1	0.2	0.2	0.2	0+	0.1	0.5	1.4	1.5	1.2	0.3	0.1	5.8
6	22-27	25-31	0+	0+	0+	0+		0+	0.2	0.4	0.4	0.3	0+		1.3
7	28-33	32-38	0+	0+					0+	0.1	0+	0.1			0.2
8	34-40	39-46							0+	0+	0+		0+		0+
9	41-47	47-54								0+					0+
10	48-55	55-63													
11	56-63	64-72													
12	> 63	> 72													
Total 4-10 kts															
Total 11-21 kts															
Total 22-33 kts															
Total 34 kts or more															
Total 4 kts or more			5.2	6.4	5.4	5.2	2.6	3.2	6.8	11.1	11.4	12.9	6.3	3.9	80.4

Notes:- 0+ < 0.05%

Under 4 kts 15.6 %

TOTAL 100.0 %

Observations missing:

REPORT ON THE INSPECTION OF THE ROAD TANK-WAGONS DAMAGED BY FIRE AT WEST LONDON TERMINAL

Nineteen road tank-wagons were damaged by fire. Fifteen were at the loading positions on the bays and four were drawn-up close to the stands awaiting vacant positions for loading. Three further vehicles were at the stands (at Bays Nos. 13, 17 and 18) at the start of the fire, but they were driven away from the area before they suffered fire damage. During the course of the fire, the vehicle standing at Bay No. 2 ran forward driverless, crossed the yard and came to rest straddling the pipe-lines along the western boundary some 30 yards from the bay.

Seven of the vehicles were owned by the Esso Petroleum Company Limited and a further four were operated and maintained by the Company under a hire arrangement with their owners, Monkton Motors Limited. Five vehicles were operated and owned by Monkton Motors Limited, two others were operated and owned by Oil-Heat Limited and the remaining vehicle was operated and owned by Alfred Manchester Limited.

Vehicles owned and operated by the Esso Petroleum Company Limited

These were positioned at Bays Nos. 8 to 13 inclusive, with one vehicle drawn up behind Bay No. 13. With one exception, the vehicles had been constructed in accordance with designs approved by a Government Inspector as suitable for the conveyance of petroleum-spirit. The vehicle not so approved differed in so far as it was fitted with a cargo pump whereas the approved design did not include this feature.

The vehicles had suffered extensive damage to the cabs as well as to the fittings to the mild steel tanks. In some cases the shell plates of the cargo tanks and the compartment division plates had been considerably distorted by heat.

It was of interest to note that although the heat and flames had severely distorted the chassis members of the vehicle standing at Bay No. 8, there remained in three of the four compartments of the tank quantities of petroleum-spirit amounting to some hundreds of gallons. The fuel tank of the vehicle also remained intact and contained a small quantity of petrol. The cargo tank of the vehicle at Bay No. 12 also contained petroleum-spirit, but in this case the quantity was small.

The cab of the vehicle standing at Bay No. 10 had been constructed of glass-reinforced plastics and during the course of the fire had been almost completely destroyed.

No unauthorised article was found on any vehicle.

Vehicles operated by the Esso Petroleum Company Limited but owned by Monkton Motors

The vehicles were of the same general design, the mild steel cargo tanks having identical capacities. They were "General Purpose" vehicles intended for the conveyance of petroleum oils as well as petroleum-spirit.

To each vehicle was fitted a plate indicating that the vehicle had been constructed in accordance with a design approved by a Government Inspector as suitable for the conveyance of petroleum-spirit.

Each vehicle differed from the approved design in that the steel guard for the draw-off taps was fitted higher than the position indicated in the approved drawing and, as fitted, the guard would not have provided adequate protection of the draw-off taps as required by regulations. Other undesirable features on each vehicle were:

- (i) the back of the cab contained two unnecessary holes which would have prejudiced the effectiveness of the back of the cab as a fire-resisting shield (again required by regulations);
- (ii) the fire-resisting framings required to be provided to the windows in the back of the cab were provided only on the outside of the cab; On one vehicle a non-flameproof lamp was fitted between the fire-resisting shield and the cargo tank. This lamp was not shown on the approved design drawing.

The vehicles at the bays had been severely damaged. The shell plates of the tanks were distorted and, in one instance, a shell plate had been ripped open by the displacement of a division plate within the tank. A number of division plates had been displaced, a few having been forced upwards so that they were jammed against the underside of the shell plates of the tanks. The chassis members of the vehicle on Bay No. 14 had undergone severe distortion. The tank fittings in many cases had been destroyed by heat.

The cab of the vehicle standing at the rear of Bay No. 16 was severely damaged by fire but the cargo tank and all its fittings had suffered only very slight damage.

Within the cab standing on Bay No. 14 was found a key of the usual type needed for unlocking the covers of the filling openings on the cargo tank. The regulations require that keys used for this purpose shall not be carried on a vehicle conveying petroleum-spirit. No other unauthorised article was found on any vehicle.

Vehicles owned and operated by Monkton Motors Limited.

The vehicles were positioned at Bays Nos. 1 to 4 inclusive and one vehicle standing behind Bay No. 3. The vehicles at Bays Nos. 1 and 2 were rigid vehicles whereas the three others were articulated. All were "General Purpose" vehicles.

There was no evidence that either rigid vehicle had been constructed to a design approved by a Government Inspector as suitable for the conveyance of petroleum-spirit. Unsatisfactory features in the designs of the vehicles were:

- (i) The guards for the draw-off taps were not considered adequate for the protection of the draw-off taps.
- (ii) No stout steel guards were fitted so as to protect the lower part of the rear of the carrying tanks.
- (iii) In one case the back of the cab contained openings which seriously prejudiced its efficiency as a fire-resisting shield.

Each vehicle had been extensively damaged. The shell plates of the aluminium tank of one vehicle had been forced outwards and burst (presumably by explosion within the tank) resulting in two roughly circular holes in the shell,

one hole having a diameter of 3 feet. There was also considerable damage to the tank fittings as well as to the cabs, one of which had been constructed largely of glass-reinforced plastics which had been destroyed.

The vehicles at Bay No. 3 and to the rear of Bay No. 3 were articulated vehicles of identical design. Neither the tractor unit nor the load carrying unit had been constructed in accordance with a design approved by a Government Inspector as suitable for the conveyance of petroleum-spirit.

The engine and batteries contained in the cabs were not efficiently screened from the cargo tank by the back of the cab, neither were the windows in the back of the cab fitted in fire-resisting framing as required by the regulations governing the conveyance of petroleum-spirit. No undesirable features were noted on the load-carrying units.

Each tractor unit had been severely damaged by fire. The fittings of the compartments at the front of the mild steel cargo tank of the unit standing at the bay were apparently undamaged. The compartments contained some hundreds of gallons of petroleum (not petroleum-spirit). The fittings at the rear of the tank had been severely damaged by fire. The front end of the load-carrying unit of the vehicle standing behind Bay No. 3 had been severely damaged. The front end plate of the tank had been forced outwards to a distance of about 3 feet from the top of the tank shell-plates. The rear-end of the tank was apparently undamaged.

The tractor unit of the vehicle positioned on Bay No. 4 was not of a design approved under the regulations governing the conveyance of petroleum-spirit. The design of the load-carrying unit of the vehicle had been approved under the regulations referred to above.

The tractor unit and certain of the tank fittings on the load-carrying unit were severely damaged. The mild steel tank however, appeared to have suffered no distortion. One of the compartments of the tank contained petroleum oil.

No unauthorised article or equipment was found on any vehicle.

Vehicles owned and operated by Oil-Heat Limited

One vehicle was stationed at Bay No. 5 whilst the other was drawn-up behind the vehicle standing at Bay No. 14.

The vehicle on Bay No. 5 was understood to have been used solely for the conveyance of heating oils and diesel fuels and, therefore, it had not been constructed to comply with the regulations governing the conveyance of petroleum-spirit. The vehicle standing to the rear of Bay No. 14 was a "General Purpose" vehicle and its design had been approved by a Government Inspector as suitable for the conveyance of petroleum-spirit.

The cab, the mild steel tank and the tank fittings of the vehicle at Bay No. 5 had been most severely damaged, whereas only the cab and forward fittings of the other vehicle had been damaged to any significant extent.

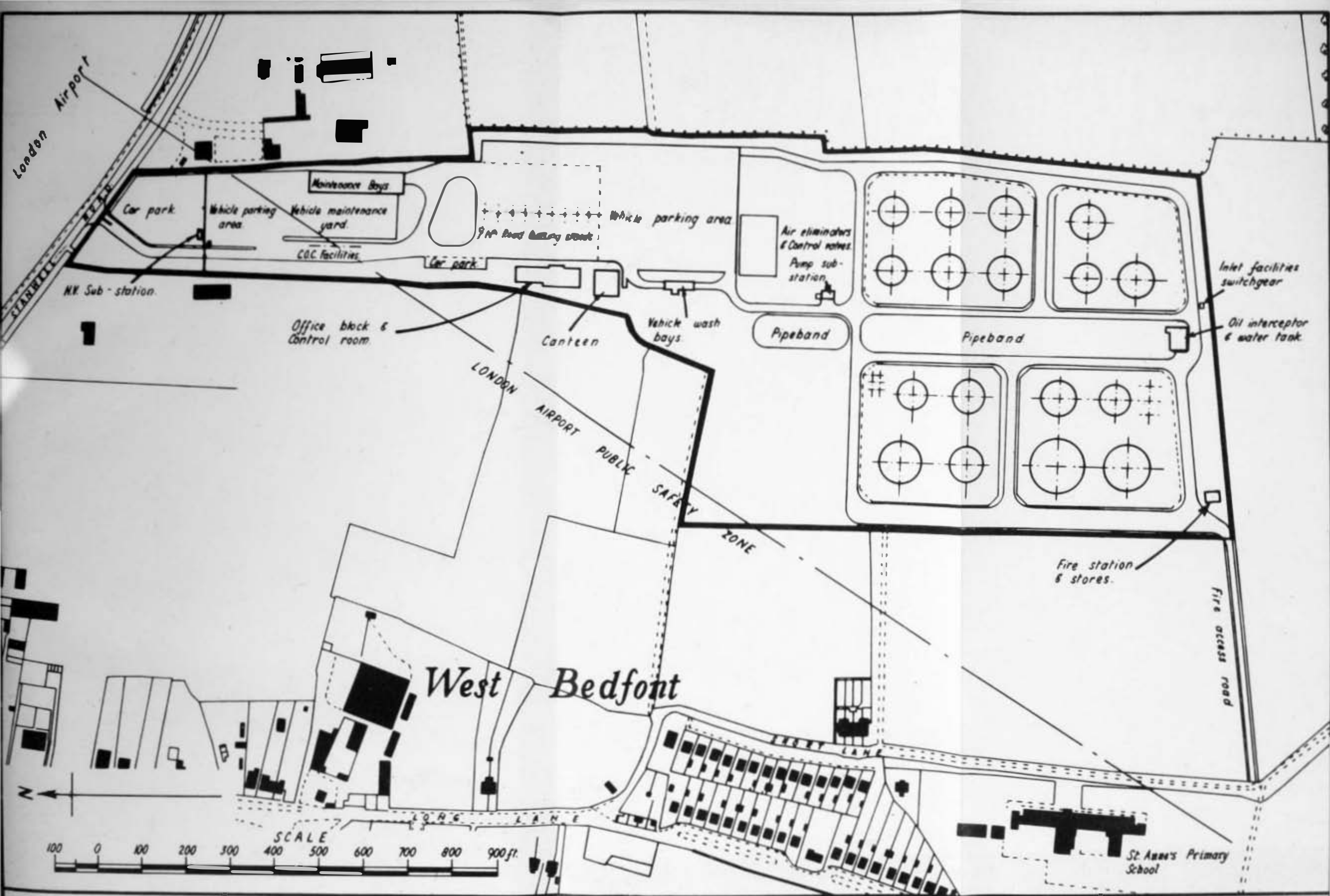
No unauthorised article was found on either vehicle.

Vehicle owned and operated by Alfred Manchester Limited

This vehicle was standing at Bay No. 7. It was identified as a vehicle constructed in accordance with a design approved by a Government Inspector as suitable for the conveyance of petroleum-spirit.

Extensive damage had been caused to the whole of the vehicle. The cab was gutted, most of the fittings for the mild steel tank had either been destroyed or rendered inoperable, the tank shell plates were badly buckled in places and some of the tank division plates had been displaced whereas others had suffered severe distortion.

No unauthorised article was found on the vehicle.

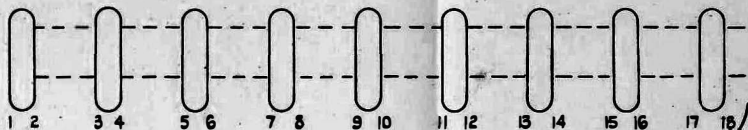


HYDRANT

BOUNDARY FENCE

6" CAST IRON FIRE MA

YARD AREA



18 No. ROAD LOADING STANDS

HYDRANT

100

OFFICE
PARK

OFFICE BLOCK & CONTROL ROOM

CANTEEN

(BURIED)

HYDRANT

ESSO PETROLEUM
WEST LONDON T
ROAD LOADING



PLAN No 2.

PIPELINES . BURIED

SCALE

100

200 FT.

CONTROL VALVES
ON PIPELINES TO
ROAD STANDS.

WASH BAYS

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